

2001 UPDATE

**ASSEMBLY BILL 970
DRAFT
NONRESIDENTIAL BUILDING
ENERGY EFFICIENCY
STANDARDS**

CONTRACTOR'S REPORT

VOLUME 2 - DRAFT STANDARD

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Gray Davis, Governor

CALIFORNIA ENERGY COMMISSION

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**California Energy Commission
Assembly Bill 970 Building Energy Efficiency Standards**

Contractor Report

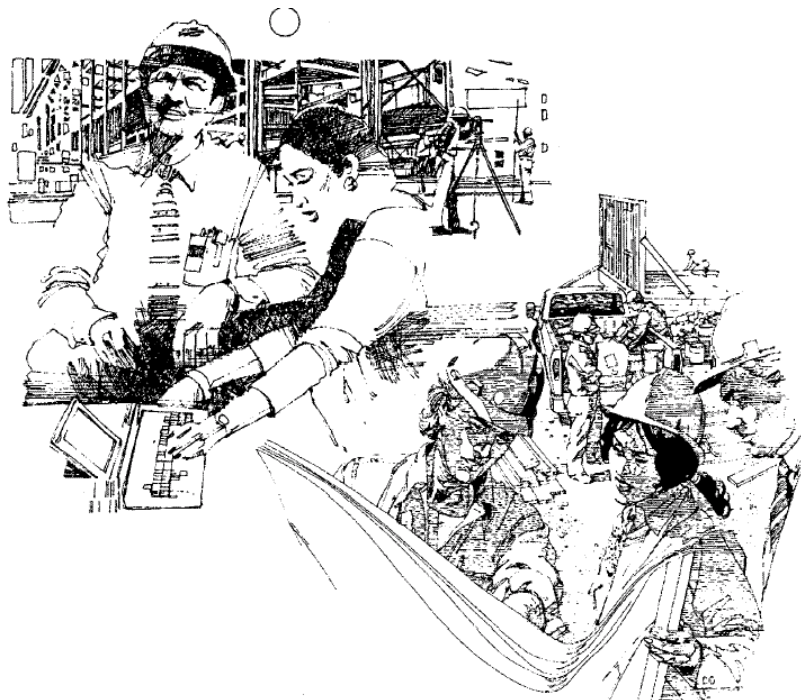
**2001 Update – AB 970 Draft Nonresidential
Building Standards**

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Draft Standard**

This Contractor Report, prepared by Eley Associates, contains the Draft Nonresidential Standard and underlines and strikethroughs for the regulation. This report is intended for discussion at an Efficiency Standards Committee hearing on November 28, 2000. The hearing purpose is to obtain public comment on this report and revisions to the Title 24 Building Energy Efficiency Standards (California Code of Regulations, Title 24, Part 6).

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November 17, 2000



Volume II – Draft Standard

Assembly Bill 970 Emergency Rulemaking – 2001 Update of California Nonresidential Energy Standards

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Introduction

This document (Volume II) is the draft standard for the 2001 update of the California Nonresidential Energy Standards. Only the sections that are proposed to be modified are contained in this document. This document is supported by three other documents. Volume I – Measure Analysis discusses the proposed changes and presents the life-cycle cost analysis that supports them. Volume III – Draft ACM Manual contains the necessary changes to the nonresidential ACM manual. Volume IV – Impact Analysis is an assessment of the statewide energy savings that are expected to result from implementation of the proposed changes.

Section 10-111 – Certification And Labeling Of Fenestration Product ~~U-Value~~U-Factors, Solar Heat Gain Coefficient, And Air Leakage

NOTE: THIS SECTION OF THE STANDARD SPECIFIES THE LABELING REQUIREMENTS FOR FENESTRATION PRODUCTS. IT IS MODIFIED TO ALLOW AN NFRC LABEL CERTIFICATE FOR SITE-BUILT FENESTRATION.

This section establishes rules for implementing labeling and certification requirements relating to U-values (also known as U-factors), solar heat gain coefficients, and air leakage for fenestration products under Section 116 (a) of Title 24, California Code of Regulations, Part 6. This section also provides for designation of the National Fenestration Rating Council (NFRC) as the supervisory entity responsible for administering the state's certification program for fenestration products, provided NFRC meets specified criteria.

(a) Labeling Requirements.

1. **Temporary labels.** Every fenestration product or fenestration system installed in construction subject to the Title 24, Part 6 shall have attached to it a clearly visible temporary label or label certificate that lists the ~~U-value~~U-factor, the solar heat gain coefficient ("SHGC") of that product and the method used to derive those values, and certifies compliance with air ~~infiltration~~leakage requirements of Section 116 (a) 1. To meet this set of requirements, products shall comply with subsections "A," "B," or "C," subsections "D," or "E," and subsection "F."

- A. If the product ~~U-value~~U-factor rating is taken from the commission's default table, then placing the words "CEC Default ~~U-value~~U-factor," followed by the appropriate default ~~U-value~~U-factor ~~from Section 116, Table 1-D,~~ on the temporary label meets the ~~U-value~~U-factor labeling requirement of paragraph 1: ~~If the product SHGC rating is taken from the commission's default table from Section 116, Table 1-E, then placing the words "CEC Default SHGC," followed by the appropriate default SHGC value meets the SHGC labeling requirement of paragraph 1.~~
- B. If the product ~~U-value~~U-factor rating is derived from the NFRC Rating Procedure, then placing the words "Manufacturer stipulates that this rating was determined in accordance with applicable NFRC procedures" followed by the rating procedure number and certified ~~U-value~~U-factor on the temporary label meets the requirement of paragraph 1.

The "NFRC Rating Procedure" as used in this subparagraph B means the National Fenestration Rating Council's ~~NFRC 100-91: Procedure for Determining Fenestration Product Thermal Properties (currently limited to U-values) (1991), or NFRC 100: Procedure for Determining Fenestration~~

Product U-factors (1997) also known as “NFRC 100”, incorporated herein by reference.

C. If the fenestration system U-factor is derived from the NFRC rating procedure and the system is a glazed wall system or overhead glazing that is site constructed, then issuance of a complete and valid NFRC Label certificate for Site-Built Products, containing the words "Manufacturer stipulates that this rating was determined in accordance with applicable NFRC procedures" (or equivalent language) followed by the rating procedure number and certified U-factor on the Label Certificate, meets the requirements of Paragraph 1. The NFRC Rating Procedure" as used in this subparagraph C, means the National Fenestration Rating Council's NFRC 100, Procedure for Determining Fenestration Product U-factors (1997), also known as NFRC 100, incorporated herein by reference.

D. If the product SHGC is taken from the Commission's default table, then placing the words "CEC Default SHGC" followed by the appropriate default SHGC from Section 116, Table 1-E on the temporary label meets the requirement of Paragraph 1.

~~EE.~~ If the product SHGC rating is derived from the NFRC Rating Procedure, placing the words “Manufacturer stipulates that this rating was determined in accordance with applicable NFRC procedures” followed by the rating procedure number and certified SHGC on the temporary label meets the requirement of paragraph 1.

The “NFRC Rating Procedure” as used in this subparagraph C means the National Fenestration Rating Council's NFRC 200: Procedure for Determining Fenestration Product Solar Heat Gain Coefficients at Normal Incidence (1995), also known as “NFRC 200”, incorporated herein by reference.

~~DE.~~ The temporary label shall also certify that the product complies with the air ~~infiltration-leakage~~ requirements of Section 116 (a) 1 of the standards.

2. **Permanent labels.** If a product is rated using the NFRC Rating Procedure, it shall be permanently labeled with either a single label or series of marks on the frame, glass, and/or spacer which can be used to trace the product to certification information on file with the certifying organization or to a directory of certified products, published by the supervisory entity, containing the name of the manufacturer, the product type and description of relevant features, the ~~U-value~~U-factor rating, solar heat gain coefficient, and the year of certification. A completed NFRC Label Certificate for Site Built Products meets the requirements of this paragraph.

EXCEPTION to Section 10-111 (a): Glazed wall systems in buildings under 100,000 square feet and overhead glazing in buildings covered by the nonresidential standards.

(b) **Certification Requirements.**

1. **Certification to default ratings.** If a product's ~~U-value~~U-factor and SHGC are taken from the commission's default tables (Section 116, Tables 1-D and 1-E), the ~~U-value~~U-factor and SHGC shall be certified by either the manufacturer or an independent certifying organization approved by the commission.
 - A. A temporary label, affixed to the product, that contains the terms “CEC Default ~~U-value~~U-factor” and “CEC Default SHGC,” followed by the appropriate values from the commission's default tables meets this requirement.
 - B. If the product claims the default ~~U-value~~U-factor for a thermal-break product, the manufacturer shall also certify on the label that the product meets the thermal-break product criteria, specified on the default table, on which the default value is based. Placing the terms “Meets Thermal-Break Default Criteria” on the temporary label meets this requirement.
2. **Certification to NFRC rating procedure.** If a product's ~~U-value~~U-factor or SHGC is based on the NFRC Rating Procedure, the ~~U-value~~U-factor or SHGC shall be certified only by an independent certifying organization approved by the commission.
 - A. A temporary label, affixed to the product or Label Certificate for Site Built Products, meeting the requirements of Section 10-111 (a) (1) (B) or 10-111 (a) (1) (C) certified by the independent certifying organization complies with this requirement.
 - B. An “independent certifying organization approved by the commission” means ~~any organization authorized by the supervisory entity to certify U-value ratings and solar heat gain coefficient ratings in accordance with the NFRC Rating Procedure. If the commission designates the NFRC as the supervisory entity, any independent certification and inspection agency (IA) licensed by NFRC, or during a start-up period, NFRC itself, shall be deemed to be an “independent certifying organization approved by the commission.”~~
 - C. The “supervisory entity” means the National Fenestration Rating Council (NFRC), except as provided in paragraph (c) 1.

EXCEPTION to Section 10-111 (b): Temporary and permanent labels are not required for glazed wall systems in buildings under 100,000 square feet and overhead glazing in buildings covered by the nonresidential standards.

- (c) **Designation of Supervisory Entity.** The National Fenestration Rating Council shall be the supervisory entity to administer the certification program relating to ~~U-value~~U-factors and solar heat gain coefficient ratings for fenestration products, provided the commission determines that the NFRC meets the criteria in paragraph (d).

1. The commission may consider designating a supervisory entity other than NFRC only if the commission determines that the NFRC cannot meet the criteria in paragraph (d).

Such other supervisory entity shall meet the criteria in paragraph (d) prior to being designated.

2. The commission shall periodically review, at least annually, the structure and operations of the supervisory entity to ensure continuing compliance with the criteria in paragraph (d).

(d) **Criteria for Supervisory Entity.**

1. Membership in the entity shall be open on a nondiscriminatory basis to any person or organization that has an interest in uniform thermal performance ratings for fenestration products, including, but not limited to, members of the fenestration industry, glazing infill industry, building industry, design professionals, specifiers, utilities, government agencies, and public interest organizations. The membership shall be composed of a broad cross section of those interested in uniform thermal performance ratings for fenestration products.
2. The governing body of the entity shall reflect a reasonable cross-section of the interests represented by the membership.
3. The entity shall maintain a program of oversight of product manufacturers, laboratories, and independent certifying organizations that ensures uniform application of the NFRC Rating Procedures, labeling and certification, and such other rating procedures for other factors affecting energy performance as the NFRC and the commission may adopt.
4. The entity shall require manufacturers and independent certifying organizations within its program to use only laboratories accredited by the supervisory entity to perform simulations and tests under the NFRC Rating Procedure.
5. The entity shall maintain appropriate guidelines for testing and simulation laboratories, manufacturers, and certifying agencies, including requirements for adequate:

Possession and calibration of equipment;

Education, competence, and training of personnel;

Quality control;

Record keeping and reporting;

Periodic review (including, but not limited to, blind testing by laboratories; inspections of products; and inspections of laboratories, manufacturing facilities, and certifying agencies);

Challenges to certified ratings; and

Guidelines to maintain the integrity of the program, including, but not limited to, provisions to avoid conflicts of interest within the rating and certification process.

6. The entity shall be a nonprofit organization and shall maintain reasonable, nondiscriminatory fee schedules for the services it provides and shall make its fee schedules, the financial information on which fees are based, and financial statements available to its members for inspection.
7. The entity shall provide hearing processes that give laboratories, manufacturers, and certifying agencies a fair review of decisions that adversely affect them.
8. The entity shall maintain a certification policy committee whose procedures are designed to avoid conflicts of interest in deciding appeals, resolving disputes, and setting policy for the certifying organizations in its program.
9. The entity shall publish at least annually a directory of products certified and decertified within its program.
10. The entity itself shall be free from conflict-of-interest ties or to undue influence from any particular fenestration manufacturing interest(s), testing or simulation lab(s), or independent certifying organization(s).
11. The entity shall provide or authorize the use of ~~labels~~ labels and Label Certificates for Site Built Products that can be used to meet the requirements of Section 116 (a) 1 and 2, ~~paragraphs B and C~~, and this section.
12. The entity's certification program shall allow for multiple participants in each aspect of the program to provide for competition between manufacturers, between testing labs, between simulation labs, and between independent certifying organizations.

- (e) **Certification for Other Factors.** Nothing in this section shall preclude any entity, whether associated with a ~~U-value~~U-factor and SHGC certification program or not, from providing certification services relating to factors other than ~~U-value~~U-factors and SHGC for fenestration products.

NOTE: Authority cited: Section 25402.1, Public Resources Code. Reference: Section 25402.1, Public Resources Code.

Section 10-113 – Certification And Labeling Of Roofing Product Reflectivity And Emissivity

This section establishes rules for implementing labeling and certification requirements relating to reflectivity and emissivity for roofing products for showing compliance with Sections 141, 142, 151(b) and 151(g) of Title 24, California Code of Regulations, Part 6. This section also provides for designation of the Cool Roof Rating Council (CRRC) as the supervisory entity responsible for administering the state's certification program for fenestration products, provided CRRC meets specified criteria.

(a) Labeling Requirements.

Effective January 1, 2003, every roofing product installed in construction to take compliance credit for reflectivity and emissivity under Sections 141, 142, 151(b) and 151(g) shall have a clearly visible packaging label that lists the reflectivity and emissivity tested in accordance with the following ASTM Standards. Product reflectivity and emissivity ratings determined through these testing procedures shall be placed on a label on all packaging which contains the product. The words “Manufacturer stipulates that this rating was determined in accordance with applicable CRRC procedures” followed by the rating procedure number and certified reflectivity and emissivity shall be placed on the packaging of the roofing products. The label shall also state any limitations or conditions of the applicability of the rating to installed roofing products.

ASTM E408 – Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.

ASTM E903 – Standard Test Method for Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres.

ASTM E1918 – Standard Test Method for Measuring Solar Reflectance of Horizontal and Low Sloped Surfaces in the Field

(b) Certification Requirements.

Effective January 1, 2003 every roofing product installed in construction to take compliance credit for reflectivity and emissivity under Sections 141, 142, 151(b) and 151(f) shall be certified only by CRRC or another supervisory entity approved by the commission pursuant to Section 10-113(c).

(c) Designation of Supervisory Entity. The Cool Roof Rating Council shall be the supervisory entity to administer the certification program relating to reflectivity and emissivity ratings for roofing products, provided the commission determines that the CRRC meets the criteria in paragraph (d).

1. The commission may consider designating a supervisory entity other than CRRC only if the commission determines that the CRRC cannot meet the criteria in paragraph (d) by

January 1, 2002. Such other supervisory entity shall meet the criteria in paragraph (d) prior to being designated.

2. The commission shall periodically review, at least annually, the structure and operations of the supervisory entity to ensure continuing compliance with the criteria in paragraph (d).

(d) Criteria for Supervisory Entity.

2. Membership in the entity shall be open on a nondiscriminatory basis to any person or organization that has an interest in uniform performance ratings for roofing products, including, but not limited to, members of the roofing industry, building industry, design professionals, specifiers, utilities, government agencies, and public interest organizations. The membership shall be composed of a broad cross section of those interested in uniform thermal performance ratings for fenestration products.

2. The governing body of the entity shall reflect a reasonable cross-section of the interests represented by the membership.

3. The entity shall maintain a program of oversight of product manufacturers, laboratories, and independent certifying organizations that ensures uniform application of the ASTM Standards E408, E903, E1918 testing and rating procedures, labeling and certification, and such other rating procedures for other factors affecting energy performance as the CRRC and the commission may adopt.

4. The entity shall require manufacturers and independent certifying organizations within its program to use only laboratories accredited by the supervisory entity to perform tests under the CRRC rating procedure.

5. The entity shall maintain appropriate guidelines for testing laboratories and manufacturers, including requirements for adequate:

- a. Possession and calibration of equipment;
- b. Education, competence, and training of personnel;
- c. Quality control;
- d. Record keeping and reporting;
- e. Periodic review (including, but not limited to, blind testing by laboratories; inspections of products; and inspections of laboratories, and manufacturing facilities);
- f. Challenges to certified ratings; and
- g. Guidelines to maintain the integrity of the program, including, but not limited to, provisions to avoid conflicts of interest within the rating and certification process.

6. The entity shall be a nonprofit organization and shall maintain reasonable, nondiscriminatory fee schedules for the services it provides and shall make its fee

schedules, the financial information on which fees are based, and financial statements available to its members for inspection.

7. The entity shall provide hearing processes that give laboratories, manufacturers, and certifying agencies a fair review of decisions that adversely affect them.
8. The entity shall maintain a certification policy committee whose procedures are designed to avoid conflicts of interest in deciding appeals, resolving disputes, and setting policy for the certifying organizations in its program.
9. The entity shall publish at least annually a directory of products certified and decertified within its program.
10. The entity itself shall be free from conflict-of-interest ties or to undue influence from any particular roof product manufacturing interest(s), testing or simulation lab(s), or independent certifying organization(s).
11. The entity shall provide or authorize the use of labels that can be used to meet the requirements for showing compliance with the requirements of Sections 141, 142, 151(b) and 151(g), and this section.
12. The entity's certification program shall allow for multiple participants in each aspect of the program to provide for competition between manufacturers and between testing labs.

Section 112 – Mandatory Requirements For Space-Conditioning Equipment

Certification by Manufacturers. Any space-conditioning equipment listed in this section may be installed only if the manufacturer has certified that the equipment complies with all the applicable requirements of this section.

- (a) **Efficiency.** Equipment shall meet the applicable requirements of Tables 1-C1 through 1-C7, subject to the following:
1. If more than one standard is listed in Tables 1-C1 through 1-C7, the equipment shall meet all the standards listed; and
 2. If more than one test method is listed in Tables 1-C1 through 1-C7, the equipment shall comply with the applicable standard when tested with each test method; and
 3. Where equipment can serve more than one function, such as both heating and cooling, or both space heating and water heating, it shall comply with all the requirements applicable to each function; and
 4. Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.
 5. Date in column is manufacturing date.

EXCEPTION to Section 112 (a): Water-cooled centrifugal water-chilling packages that are not designed for operation at ARI Standard 550 test conditions (and thus cannot be tested to meet the requirements of Table 1-C3) of 44°F leaving chilled water temperature and 85°F entering condenser water temperature shall have a minimum full load COP and IPLV rating as shown in Tables 1-C8, 1-C9, and 1-C10. The table values are only applicable over the following full load design ranges:

Leaving Chiller Water Temp.:	40 to 48°F
Entering Condenser Water Temp.:	75 to 85°F
Condensing Water Temp. Rise:	5 to 15°F

**TABLE 1-C EFFICIENCY REQUIREMENTS FOR
SPACE-CONDITIONING EQUIPMENT**

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	EFFICIENCY REQUIREMENT	WHEN TESTED WITH:
UNITARY AIR CONDITIONERS AND HEAT PUMPS, ELECTRICALLY OPERATED > 135,000 BTU/HR.				
Air conditioners, air cooled	≥ 135,000 Btu/hr.	—	8.5 EER	ARI 360-93
	< 760,000 Btu/hr.	—	7.5 IPLV	
	≥ 760,000 Btu/hr.	—	8.2 EER	ARI 360-93
		—	7.5 IPLV	
Air conditioners, water or evaporatively cooled	≥ 135,000 Btu/hr.	—	9.6 EER	ARI 360-93
		—	9.0 IPLV	STD 201 (96)
Heat pumps, air cooled, cooling mode	≥ 135,000 Btu/hr.	—	8.5 EER	ARI 340-93
	< 760,000 Btu/hr.	—	7.5 IPLV	
	≥ 760,000 Btu/hr.	—	8.2 EER	ARI 340-93
		—	7.5 IPLV	
Heat pumps, air cooled, heating mode	≥ 135,000 Btu/hr.	47°F	2.9 COP	ARI 340-93
		17°F	2.0 COP	
Condensing units, air cooled	≥ 135,000 Btu/hr.	—	9.9 EER	ARI 365-94
		—	11.0 IPLV	
Condensing units, water or evaporatively cooled	≥ 135,000 Btu/hr.	—	12.9 EER	ARI 365-94
		—	12.9 IPLV	STD 201 (96)
WATER CHILLING PACKAGES, WATER AND AIR COOLED, ELECTRICALLY OPERATED				
Water cooled	< 150 tons	—	3.8 COP	STD 201 (96)
		—	3.9 IPLV	ARI 550-92
		—		ARI 590-92
	≥ 150 < 300 tons	—	4.2 COP	STD 201 (96)
		—	4.5 IPLV	ARI 550-92
		—		ARI 590-92
	≥ 300 tons	With CFC refrigerants with ozone depletion factors greater than those for R-22	5.2 COP	STD 201 (96)
			5.3 IPLV	ARI 550-92
				ARI 590-92
Water cooled		All others	4.7 COP	STD 201 (96)
		All others	4.8 IPLV	ARI 550-92
		All others		ARI 590-92
Air cooled	< 150 tons	With condenser	2.7 COP	ARI 550-92
		With condenser	2.8 IPLV	ARI 590-92
		With condenser		
	≥ 150 tons	With condenser	2.5 COP	ARI 550-92
		With condenser	2.5 IPLV	ARI 590-92
		With condenser		
	All sizes	Without condenser	3.1 COP	ARI 550-92
		Without condenser	3.2 IPLV	ARI 590-92
		Without condenser		
BOILERS				
Gas-fired	≥ 300,000 Btu/hr.	At both maximum and minimum rated capacity	80% combustion efficiency	ANSI Z21.13-91 HI Heating Boiler —Standard 89 ASME PTC 4.1-64 ANSI/UL 795-94
Oil-fired	≥ 225,000 < 300,000 Btu/hr.		80% AFUE	10 C.F.R. Part 430, Appendix N
	≥ 300,000 Btu/hr.	At both maximum and minimum rated capacity	83% combustion efficiency	HI Heating Boiler —Standard 89 ASME PTC 4.1-64 ANSI/UL 726-90
Oil-fired (residual)	≥ 300,000 Btu/hr.	At both maximum and minimum rated capacity	83% combustion efficiency	HI Heating Boiler —Standard 89 ASME PTC 4.1-64

**TABLE 1-C EFFICIENCY REQUIREMENTS FOR
SPACE-CONDITIONING EQUIPMENT
(Continued)**

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	EFFICIENCY REQUIREMENT	WHEN TESTED WITH:
WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS				
Gas-fired	$\geq 225,000$ Btu/hr.	At maximum rated capacity	80% thermal efficiency	ANSI Z21.47-93
		At maximum rated capacity	78% thermal efficiency	ANSI Z21.47-93
Oil-fired	$\geq 225,000$ Btu/hr.	At both maximum and minimum rated capacity	81% thermal efficiency	ANSI/UL 727-86
UNIT HEATERS				
Oil-fired	All sizes	At maximum rated capacity	81% thermal efficiency	UL 731-95
	All sizes	At maximum rated capacity	81% thermal efficiency	UL 731-95

**TABLE 1-C1 ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND
CONDENSING UNITS – MINIMUM EFFICIENCY REQUIREMENTS**

Equipment Type	Size Category	Sub-Category or Rating Condition	Efficiency prior to 10/29/2001 ^a	Efficiency as of 10/29/2001 ^a	Test Procedure
Air Conditioners, Air Cooled	$\geq 65,000$ Btu/h and $< 135,000$ Btu/h	Split System and Single Package	8.9 EER 8.3 IPLV	10.3 EER ^b -	ARI 210/240
	$\geq 135,000$ Btu/h and $< 240,000$ Btu/h	Split System and Single Package	8.5 EER 7.5 IPLV	9.7 EER ^b -	ARI 340/360
	$\geq 240,000$ Btu/h and $< 760,000$ Btu/h	Split System and Single Package	8.5 EER 7.5 IPLV	9.5 EER ^b 9.7 IPLV ^b	
	$\geq 760,000$ Btu/h	Split System and Single Package	8.2 EER 7.5 IPLV	9.2 EER ^b 9.4 IPLV ^b	
	$> 65,000$ Btu/h and $< 135,000$ Btu/h	Split System and Single Package	10.5 EER 9.7 IPLV	11.5 EER ^b -	ARI 210/240
Air Conditioners, Water and Evaporatively Cooled	$\geq 135,000$ Btu/h and $\leq 240,000$ Btu/h	Split System and Single Package	9.6 EER 9.0 IPLV	11.0 EER ^b -	ARI 340/360
	$> 240,000$ Btu/h	Split System and Single Package	9.6 EER 9.0 IPLV	11.0 EER ^b 10.3 IPLV ^b	
	-	-	-	-	-
Condensing Units, Air Cooled	$\geq 135,000$ Btu/h	-	9.9 EER 11.0 IPLV	10.1 EER 11.2 IPLV	ARI 365
Condensing Units, Water or Evaporatively Cooled	$\geq 135,000$ Btu/h	-	12.9 EER 12.9 IPLV	13.1 EER 13.1 IPLV	

^a IPLVs are only applicable to equipment with capacity modulation.

^b Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

**TABLE 1-C2 UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY OPERATED –
MINIMUM EFFICIENCY REQUIREMENTS**

Equipment Type	Size Category	Sub-Category or Rating Condition	Efficiency prior to 10/29/2001	Efficiency as of 10/29/2001 ^a	Test Procedure
Air Cooled, (Cooling Mode)	≥65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	8.9 EER 8.3 IPLV	10.1 EER ^b	ARI 210/240
	≥135,000 Btu/h and <240,000 Btu/h	Split System and Single Package	8.5 EER 7.5 IPLV	9.3 EER ^b	ARI 340/360
	≥240,000 Btu/h <760,000 Btu/h	Split System and Single Package	8.5 EER 7.5 IPLV	9.0 EER ^b 9.2 IPLV ^b	-
	≥760,000 Btu/h	Split System and Single Package	8.2 EER 7.5 IPLV	9.0 EER ^b 9.2 IPLV ^b	-
	€				
Water-Source (Cooling Mode)	< 17,000 Btu/h	85°F Entering Water	10.0 EER	-	ARI 320
	-	86°F Entering Water	-	11.2 EER	ARI/ISO-13256-1
	≥ 17,000 Btu/h and <65,000 Btu/h	85°F Entering Water	10.0 EER	-	ARI 320
	-	86°F Entering Water	-	12.0 EER	ARI/ISO-13256-1
	≥65,000 Btu/h and < 135,000 Btu/h	85°F Entering Water	10.5 EER	-	ARI 320
	-	86°F Entering Water	-	12.0 EER	ARI/ISO-13256-1
Groundwater-Source (Cooling Mode)	< 135,000 Btu/h	70°F Entering Water	11.0 EER	-	ARI 325
	-	59°F Entering Water	-	16.2 EER	ARI/ISO-13256-1
Ground Source (Cooling Mode)	< 135,000 Btu/h	77°F Entering Water	N/A	13.4 EER	ARI/ISO-13256-1
Air Cooled (Heating Mode)	≥65,000 Btu/h and < 135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.0 COP	3.2 COP	ARI 210/240
	-	-	-	-	-
	≥135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	2.9 COP	3.1 COP	ARI 340/360
Water-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	70°F Entering Water	3.8 COP	-	ARI 320
	-	68°F Entering Water	-	4.2 COP	ARI/ISO-13256-1
Groundwater-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	70°F Entering Water	3.5 COP	-	ARI 325
	-	50°F Entering Water	-	3.6 COP	ARI/ISO-13256-1
Ground Source (Heating Mode)	(Cooling Capacity)	32 °F Entering Water	N/A	3.1 COP	ARI/ISO-13256-1

^a IPLVs and Part load rating conditions are only applicable to equipment with capacity modulation.

^b Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

TABLE 1-C3 WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS

<u>Equipment Type</u>	<u>Size Category</u>	<u>Efficiency prior to 10/29/2001</u>	<u>Efficiency as of 10/29/2001</u>	<u>Test Procedure</u>
<u>Air Cooled, With Condenser, Electrically Operated</u>	<u>< 150 Tons</u>	<u>2.70 COP</u>	<u>2.80 COP</u> <u>2.80 IPLV</u>	<u>ARI 550</u> <u>or</u> <u>ARI 590</u> <u>as appropriate</u>
	<u>-</u>	<u>2.80 IPLV</u>		
	<u>≥150 Tons</u>	<u>2.50 COP</u> <u>2.50 IPLV</u>		
<u>Air Cooled, Without Condenser, Electrically Operated</u>	<u>All Capacities</u>	<u>3.10 COP</u>	<u>3.10 COP</u> <u>3.10 IPLV</u>	<u>-</u> <u>-</u> <u>-</u>
	<u>-</u>	<u>3.20 IPLV</u>		
	<u>-</u>	<u>-</u>		
<u>Water Cooled, Electrically Operated, Positive Displacement (Reciprocating)</u>	<u>All Capacities</u>	<u>3.80 COP</u>	<u>4.20 COP</u>	<u>ARI 590</u>
	<u>-</u>	<u>3.90 IPLV</u>	<u>4.65 IPLV</u>	<u>-</u>
<u>Water Cooled, Electrically Operated, Positive Displacement (Rotary Screw and Scroll)</u>	<u>< 150 Tons</u>	<u>3.80 COP</u>	<u>4.45 COP</u>	<u>ARI 550</u> <u>or</u> <u>ARI 590</u> <u>as appropriate</u>
	<u>-</u>	<u>3.90 IPLV</u>	<u>4.50 IPLV</u>	
	<u>-</u>	<u>-</u>	<u>-</u>	
	<u>≥150 Tons and < 300 Tons</u>	<u>4.20 COP</u> <u>4.50 IPLV</u>	<u>4.90 COP</u> <u>4.95 IPLV</u>	
	<u>≥300 Tons</u> <u>€</u>	<u>5.20 COP</u> <u>5.30 IPLV</u>	<u>5.50 COP</u> <u>5.60 IPLV</u>	
<u>Water Cooled, Electrically Operated, Centrifugal</u> <u>-</u>	<u>< 150 Tons</u>	<u>3.80 COP</u>	<u>5.00 COP</u>	<u>-</u> <u>ARI 550</u>
	<u>-</u>	<u>3.90 IPLV</u>	<u>5.00 IPLV</u>	
	<u>≥150 Tons and < 300 Tons</u>	<u>4.20 COP</u> <u>4.50 IPLV</u>	<u>5.55 COP</u> <u>5.55 IPLV</u>	
	<u>≥300 Tons</u>	<u>5.20 COP</u>	<u>6.10 COP</u>	
	<u>€</u>	<u>5.30 IPLV</u>	<u>6.10 IPLV</u>	
<u>Air Cooled Absorption Single Effect</u>	<u>All Capacities</u>	<u>N/A</u>	<u>0.60 COP</u>	<u>-</u> <u>-</u> <u>-</u> <u>-</u> <u>ARI 560</u>
<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	
<u>Water Cooled Absorption Single Effect</u>	<u>All Capacities</u>	<u>N/A</u>	<u>0.70 COP</u>	
<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	
<u>Absorption Double Effect, Indirect-Fired</u>	<u>All Capacities</u>	<u>N/A</u>	<u>1.00 COP</u> <u>1.05 IPLV</u>	
<u>-</u>	<u>-</u>	<u>N/A</u>	<u>-</u>	
<u>Absorption Double Effect, Direct-Fired</u>	<u>All Capacities</u>	<u>N/A</u>	<u>1.00 COP</u> <u>1.00 IPLV</u>	<u>-</u> <u>-</u>
<u>-</u>	<u>-</u>	<u>N/A</u>	<u>-</u>	

TABLE 1-C4 PACKAGED TERMINAL AIR CONDITIONERS AND PACKAGED TERMINAL HEAT PUMPS – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Efficiency prior to 10/29/2001 ^a	Efficiency as of 10/29/2001 ^a	Test Procedure
PTAC (Cooling Mode) New Construction	All Capacities	95°F db Outdoor Air	$10.0 - (0.16 \times \frac{\text{Cap/1000}^a}{\text{EER}})$	$12.5 - (0.213 \times \frac{\text{Cap/1000}^a}{\text{EER}})$	-
PTAC (Cooling Mode) Replacements ^c	All Capacities	95°F db Outdoor Air	$10.0 - (0.16 \times \frac{\text{Cap/1000}^a}{\text{EER}})$	$10.9 - (0.213 \times \frac{\text{Cap/1000}^a}{\text{EER}})$	ARI 310/380
PTHP (Cooling Mode) New Construction	All Capacities	95°F db Outdoor Air	$10.0 - (0.16 \times \frac{\text{Cap/1000}^a}{\text{EER}})$	$12.3 - (0.213 \times \frac{\text{Cap/1000}^a}{\text{EER}})$	-
PTHP (Cooling Mode) Replacements ^c	All Capacities	95°F db Outdoor Air	$10.0 - (0.16 \times \frac{\text{Cap/1000}^a}{\text{EER}})$	$10.8 - (0.213 \times \frac{\text{Cap/1000}^a}{\text{EER}})$	-
PTHP (Heating Mode) New Construction	All Capacities	-	$2.9 - (0.026 \times \frac{\text{Cap/1000}^a}{\text{COP}})$	$3.2 - (0.026 \times \frac{\text{Cap/1000}^a}{\text{COP}})$	-
PTHP (Heating Mode) Replacements ^b	All Capacities	-	$2.9 - (0.026 \times \frac{\text{Cap/1000}^a}{\text{COP}})$	$2.9 - (0.026 \times \frac{\text{Cap/1000}^a}{\text{COP}})$	-

^a Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

^b Replacement units must be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16-in. high and less than 42-in. wide.

TABLE 1-C5 WARM AIR FURNACES AND COMBINATION WARM AIR FURNACES/AIR-CONDITIONING UNITS, WARM AIR DUCT FURNACES AND UNIT HEATERS – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Efficiency prior to 10/29/2001 ^a	Efficiency as of 10/29/2001	Test Procedure
Warm Air Furnace, Gas-Fired	≥225,000 Btu/h (66 kW)	Maximum Capacity Minimum Capacity ^c	80% E _t 78% E _t	80% E _c ^b	ANSI Z21.47
Warm Air Furnace, Oil-Fired	≥225,000 Btu/h (66 kW)	Maximum Capacity Minimum Capacity ^c	81% E _t 81% E _t	81% E _t ^a —	UL 727
Warm Air Duct Furnaces, Gas-Fired	All Capacities	Maximum Capacity Minimum Capacity ^c	80% E _t 75% E _t	80% E _c ^b —	ANSI Z83.9
Warm Air Unit Heaters, Gas-Fired	All Capacities	Maximum Capacity Minimum Capacity ^c	80% E _t 74% E _t	80% E _c ^b —	ANSI Z83.8
Warm Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity Minimum Capacity ^c	81% E _t 81% E _t	80% E _c ^b —	UL 731

^a E_t = Thermal efficiency. See test procedure for detailed discussion.

^b E_c = Combustion efficiency (100% less flue losses). See test procedure for detailed discussion.

^c Minimum ratings as provided for and allowed by unit's controls.

TABLE 1-C6 BOILERS, GAS- AND OIL-FIRED – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type ¹	Size Category	Sub-Category or Rating Condition	Efficiency prior to 10/29/2001 ^d	Efficiency as of 10/29/2001	Test Procedure
Boilers, Gas-Fired	$\geq 300,000$ Btu/h	Maximum Capacity ^a	80% E_c ^b	75% E_t ^c	H.I. Htg Boiler Std
		Minimum Capacity ^a	80% E_c ^b		
	$> 2,500,000$ Btu/h ^e	Hot Water	80% E_c ^b	80% E_c ^b	
	$> 2,500,000$ Btu/h ^e	Steam	80% E_c ^b	80% E_c ^b	
Boilers, Oil-Fired	$\geq 300,000$ Btu/h and $\leq 2,500,000$ Btu/h	Maximum Capacity ^a	83% E_c ^b	78% E_t ^c	H.I. Htg Boiler Std
		Minimum Capacity ^a	83% E_c ^b		
	$> 2,500,000$ Btu/h ^e	Hot Water	83% E_c ^b	83% E_c ^b	
	$> 2,500,000$ Btu/h ^e	Steam	83% E_c ^b	83% E_c ^b	
Oil-Fired (Residual)	$\geq 300,000$ Btu/h and $\leq 2,500,000$ Btu/h	Maximum Capacity ^a	83% E_c ^b	78% E_t ^c	H.I. Htg Boiler Std
		Minimum Capacity ^a	83% E_c ^b		
	$> 2,500,000$ Btu/h ^e	Hot Water	83% E_c ^b	83% E_c ^b	
	$> 2,500,000$ Btu/h ^e	Steam	83% E_c ^b	83% E_c ^b	

^a Minimum and maximum ratings as provided for and allowed by the unit's controls.

^b E_c = Combustion efficiency (100% less flue losses). See reference document for detailed information.

^c E_t = Thermal efficiency. See reference document for detailed information.

^d Alternate test procedures used at the manufacturer's option are ASME PTC-4.1 for units over 5,000,000 Btu/h input, or ANSI Z21.13 for units greater than or equal to 300,000 Btu/h and less than or equal to 2,500,000 Btu/h input.

^e These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers, and to all packaged boilers. minimum efficiency requirements for boilers cover all capacities of packaged boilers.

TABLE 1-C7 PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT

<u>Equipment Type</u>	<u>Total System Heat Rejection Capacity at Rated Conditions</u>	<u>Sub-Category or Rating Condition</u>	<u>Performance Required as of 10/29/2001^{a,b}</u>	<u>Test Procedure</u>
<u>Propeller or Axial Fan Cooling Towers</u>	<u>All</u>	<u>95°F Entering Water</u> <u>85°F Leaving Water</u> <u>78°F wb Outdoor Air</u>	<u>≥38.2 gpm/hp</u> <u>-</u>	<u>CTI ATC-105</u> <u>and</u> <u>CTI STD-201</u>
<u>Centrifugal Fan Cooling Towers</u>	<u>All</u>	<u>95°F Entering Water</u> <u>85°F Leaving Water</u> <u>78°F wb Outdoor Air</u>	<u>≥ 20.0 gpm/hp</u> <u>-</u>	<u>CTI ATC-105</u> <u>and</u> <u>CTI STD-201</u>
<u>Air Cooled Condensers</u>	<u>All</u>	<u>125°F Condensing Temperature</u> <u>R22 Test Fluid</u> <u>190°F Entering Gas Temperature</u> <u>15°F Subcooling</u> <u>95°F Entering Drybulb</u>	<u>≥176,000 Btu/h-hp</u> <u>-</u>	<u>ARI 460</u>
^a For purposes of this table, cooling tower performance is defined as the maximum flow rating of the tower divided by the fan nameplate rated motor power.				
^b For purposes of this table air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan nameplate rated motor power.				

TABLE 1-C8 COPS AND IPLVS FOR NON-STANDARD CENTRIFUGAL CHILLERS < 150 TONS

Centrifugal Chillers < 150 Tons								
$COP_{std} = 5.4$								
			Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT ^a (°F)	-					
			-					
			Required COP and IPLV (IPLV=COP)					
46	75	29	6.00	6.27	6.48	6.8	7.03	7.20
45	75	30	5.92	6.17	6.37	6.66	6.87	7.02
44	75	31	5.84	6.08	6.26	6.53	6.71	6.86
43	75	32	5.75	5.99	6.16	6.4	6.58	6.71
42	75	33	5.67	5.9	6.06	6.29	6.45	6.57
41	75	34	5.59	5.82	5.98	6.19	6.34	6.44
40	75	35	5.50	5.74	5.89	6.10	6.23	6.33
46	80	34	5.59	5.82	5.98	6.19	6.34	6.44
45	80	35	5.50	5.74	5.89	6.10	6.23	6.33
44	80	36	5.41	5.66	5.81	6.01	6.13	6.22
43	80	37	5.31	5.57	5.73	5.92	6.04	6.13
42	80	38	5.21	5.48	5.64	5.84	5.95	6.04
41	80	39	5.09	5.39	5.56	5.76	5.87	5.95
40	80	40	4.96	5.29	5.47	5.67	5.79	5.86
46	85	39	5.09	5.39	5.56	5.76	5.87	5.95
45	85	40	4.96	5.29	5.47	5.67	5.79	5.86
44	85	41	4.83	5.18	5.40	5.59	5.71	5.78
43	85	42	4.68	5.07	5.28	5.50	5.62	5.70
42	85	43	4.51	4.94	5.17	5.41	5.54	5.62
41	85	44	4.33	4.8	5.05	5.31	5.45	5.53
40	85	45	4.13	4.65	4.92	5.21	5.35	5.44
Condenser DT ^b			14.04	11.23	9.36	7.02	5.62	4.68
^a LIFT = Entering Condenser Water Temperature – Leaving Chilled Water Temperature ^b Condenser DT = Leaving Condenser Water Temperature (F) – Entering Condenser Water Temperature (F) $K_{adj} = 6.1507 - 0.30244(X) + 0.0062692(X)^2 - 0.000045595(X)^3$ where X = Condenser DT + LIFT $COP_{adj} = K_{adj} * COP_{std}$								

TABLE 1-C9 COPS AND IPLVS FOR NON-STANDARD CENTRIFUGAL CHILLERS > 150 TONS, ≤ 300 TONS

Centrifugal Chillers > 150 Tons, ≤ 300 Tons										
COP _{std} = 5.55										
			Condenser Flow Rate							
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton		
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT ^a (°F)	-							
			-							
			Required COP and IPLV (IPLV=COP)							
46	75	29	6.17	6.44	6.66	6.99	7.23	7.40		
45	75	30	6.08	6.34	6.54	6.84	7.06	7.22		
44	75	31	6.00	6.24	6.43	6.71	6.9	7.05		
43	75	32	5.91	6.15	6.33	6.58	6.76	6.89		
42	75	33	5.83	6.07	6.23	6.47	6.63	6.75		
41	75	34	5.74	5.98	6.14	6.36	6.51	6.62		
40	75	35	5.65	5.90	6.05	6.26	6.40	6.51		
46	80	34	5.74	5.98	6.14	6.36	6.51	6.62		
45	80	35	5.65	5.90	6.05	6.26	6.40	6.51		
44	80	36	5.56	5.81	5.97	6.17	6.30	6.40		
43	80	37	5.46	5.73	5.89	6.08	6.21	6.30		
42	80	38	5.35	5.64	5.8	6.00	6.12	6.20		
41	80	39	5.23	5.54	5.71	5.91	6.03	6.11		
40	80	40	5.10	5.44	5.62	5.83	5.95	6.03		
46	85	39	5.23	5.54	5.71	5.91	6.03	6.11		
45	85	40	5.10	5.44	5.62	5.83	5.95	6.03		
44	85	41	4.96	5.33	5.55	5.74	5.86	5.94		
43	85	42	4.81	5.21	5.42	5.66	5.78	5.86		
42	85	43	4.63	5.08	5.31	5.56	5.69	5.77		
41	85	44	4.45	4.93	5.19	5.46	5.60	5.69		
40	85	45	4.24	4.77	5.06	5.35	5.50	5.59		
Condenser DT ^b			14.04	11.23	9.36	7.02	5.62	4.68		
^a LIFT = Entering Condenser Water Temperature – Leaving Chilled Water Temperature										
^b Condenser DT = Leaving Condenser Water Temperature (F) - Entering Condenser Water Temperature (F)										
$K_{adj} = 6.1507 - 0.30244(X) + 0.0062692(X)^2 - 0.000045595(X)^3$										
where X = Condenser DT + LIFT										
$COP_{adj} = K_{adj} * COP_{std}$										

TABLE 1-C10 COPS AND IPLVS FOR NON-STANDARD CENTRIFUGAL CHILLERS > 300 TONS

Centrifugal Chillers > 300 Tons								
COP _{std} = 6.1								
			Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT ^a (°F)	-					
			-					
			Required COP and IPLV (IPLV=COP)					
46	75	29	6.80	7.11	7.35	7.71	7.97	8.16
45	75	30	6.71	6.99	7.21	7.55	7.78	7.96
44	75	31	6.61	6.89	7.09	7.40	7.61	7.77
43	75	32	6.52	6.79	6.98	7.26	7.45	7.60
42	75	33	6.43	6.69	6.87	7.13	7.31	7.44
41	75	34	6.33	6.60	6.77	7.02	7.18	7.30
40	75	35	6.23	6.50	6.68	6.91	7.06	7.17
46	80	34	6.33	6.60	6.77	7.02	7.18	7.30
45	80	35	6.23	6.50	6.68	6.91	7.06	7.17
44	80	36	6.13	6.41	6.58	6.81	6.95	7.05
43	80	37	6.02	6.31	6.49	6.71	6.85	6.94
42	80	38	5.90	6.21	6.40	6.61	6.75	6.84
41	80	39	5.77	6.11	6.30	6.52	6.65	6.74
40	80	40	5.63	6.00	6.20	6.43	6.56	6.65
46	85	39	5.77	6.11	6.30	6.52	6.65	6.74
45	85	40	5.63	6.00	6.20	6.43	6.56	6.65
44	85	41	5.47	5.87	6.10	6.33	6.47	6.55
43	85	42	5.30	5.74	5.98	6.24	6.37	6.46
42	85	43	5.11	5.60	5.86	6.13	6.28	6.37
41	85	44	4.90	5.44	5.72	6.02	6.17	6.27
40	85	45	4.68	5.26	5.58	5.90	6.07	6.17
Condenser DT ^b			14.04	11.23	9.36	7.02	5.62	4.68
^a LIFT = Entering Condenser Water Temperature – Leaving Chilled Water Temperature ^b Condenser DT = Leaving Condenser Water Temperature (F) - Entering Condenser Water Temperature (F) $K_{adj} = 6.1507 - 0.30244(X) + 0.0062692(X)^2 - 0.000045595(X)^3$ where X = Condenser DT + LIFT $COP_{adj} = K_{adj} * COP_{std}$								

(b) **Controls for Heat Pumps with Supplementary Electric Resistance Heaters.** Heat pumps with supplementary electric resistance heaters shall have controls:

1. That prevent supplementary heater operation when the heating load can be met by the heat pump alone; and
2. In which the cut-on temperature for compression heating is higher than the cut-on temperature for supplementary heating, and the cut-off temperature for compression heating is higher than the cut-off temperature for supplementary heating.

EXCEPTION to Section 112 (b): The controls may allow supplementary heater operation during:

- A. Defrost; and
- B. Transient periods such as start-ups and following room thermostat setpoint advance, if the controls provide preferential rate control, intelligent recovery, staging, ramping or another control mechanism designed to preclude the unnecessary operation of supplementary heating.

(c) **Gas- and Oil-Fired Furnace Standby Loss Controls**

Gas-fired and oil-fired forced air furnaces with input ratings $\geq 225,000$ Btu/h shall also have an intermittent ignition or interrupted device (IID), and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for furnaces where combustion air is drawn from the conditioned space. All furnaces with input ratings $\geq 225,000$ Btu/h, including electric furnaces, that are not located within the conditioned space shall have jacket losses not exceeding 0.75% of the input rating.

Section 113 – Mandatory Requirements For Service Water-Heating Systems And Equipment

- (a) **Certification by Manufacturers.** Any service water-heating system or equipment may be installed only if the manufacturer has certified that the system or equipment complies with all of the requirements of this subsection for that system or equipment.

1. **Temperature controls for service water-heating systems.** Service water-heating systems shall be equipped with automatic temperature controls capable of adjustment from the lowest to the highest acceptable temperature settings for the intended use as listed in Table 3, Chapter 45 of the 1995 ASHRAE Handbook, HVAC Applications Volume.

EXCEPTION to Section 113 (a) 1: Residential occupancies.

- (b) **Efficiency.** Equipment shall meet the applicable requirements of Table 1-C11, subject to the following:

1. If more than one standard is listed in Table 1-C11, the equipment shall meet all the standards listed; and
2. If more than one test method is listed in Table 1-C11, the equipment shall comply with the applicable standard when tested with each test method; and
3. Where equipment can serve more than one function, such as both heating and cooling, or both space heating and water heating, it shall comply with all the requirements applicable to each function; and
4. Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.

- (bc) **Installation.** Any service water-heating system or equipment may be installed only if the system or equipment complies with all of the applicable requirements of this subsection for the system or equipment.

1. **Outlet temperature controls.** On systems that have a total capacity greater than 167,000 Btu/hr., outlets that require higher than service water temperatures as listed in the 1995 ASHRAE Handbook, HVAC Applications Volume, shall have separate remote heaters, heat exchangers, or boosters to supply the outlet with the higher temperature.
2. **Pumps for circulating systems.** Circulating service water-heating systems shall have a control capable of automatically turning off the circulating pump when hot water is not required.

EXCEPTION to Section 113 (b)(2): Residential occupancies.

3. **Temperature controls for public lavatories.** The controls shall limit the outlet temperature to 110°F.
4. **Insulation.** Unfired service water heater storage tanks and backup tanks for solar water-heating systems shall have:
 - A. External insulation with an installed R-value of at least R-12; or
 - B. Internal and external insulation with a combined R-value of at least R-16; or
 - C. The heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.
5. **Service water heaters in state buildings.** Any new building constructed by the State shall derive its service water heating from a system that provides at least 60 percent of the energy needed for service water heating from site solar energy or recovered energy.

EXCEPTION to Section 113 (b)(5): Buildings for which the state architect determines that service water heating from site solar energy or recovered energy is economically or physically infeasible.

TABLE 1-C11 MINIMUM EFFICIENCY REQUIREMENTS FOR WATER HEATING EQUIPMENT

Equipment Type	Size Category	Sub-Category or Rating Condition	Performance Required up to 10/29/2001 ^{a, b}	Performance Required as of 10/29/2001 ^b	Test Procedure
Gas Storage Water Heaters	> 105,000 Btu/h and ≤ 155,000 Btu/h	< 4,000 Btu/h/gal	78% E _t	80% E _t	ANSI Z21.10.3
			7.47V + 655 SL _t Btu/h	(Q/800 + 110√V) SL _t Btu/h	
	> 155,000 Btu/h	< 4,000 Btu/h/gal	78% E _t	80% E _t	
Gas Instantaneous Water Heaters	> 200,000 Btu/h ^c	> 4,000 Btu/h/gal and < 10 gal	80% E _t	80% E _t	ANSI Z21.10.3
	> 200,000 Btu/h ^c	> 4,000 Btu/h/gal and ≥ 10 gal	77% E _t	80% E _t	
			13.22V + 385 SL _t Btu/h	(Q/800 + 110√V) SL _t Btu/h	
Oil Storage Water Heaters	> 105,000 Btu/h and ≤ 155,000 Btu/h	< 4,000 Btu/h/gal	78% E _t	78% E _t	ANSI Z21.10.3
			7.47V + 655 SL _t Btu/h	(Q/800 + 110√V) SL _t Btu/h	
	> 155,000 Btu/h	< 4,000 Btu/h/gal	78% E _t	78% E _t	
Oil Instantaneous Water Heaters	> 210,000 Btu/h ^c	> 4,000 Btu/h/gal and < 10 gal	80% E _t	80% E _t	ANSI Z21.10.3
	> 210,000 Btu/h ^c	> 4,000 Btu/h/gal and ≥ 10 gal	77% E _t	78% E _t	
			13.22V + 385 SL _t Btu/h	(Q/800 + 110√V) SL _t Btu/h	

^a Energy factor (EF) and thermal efficiency (E_t) are minimum requirements, while standby loss (SL) are maximum Btu/h based on a nominal 70°F temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in gallons. In the SL equation, V is the measured volume in gallons.

^b Energy factor (EF) and thermal efficiency (E_t) are minimum requirements, while standby loss (SL) is maximum Btu/h based on a 70° temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in gallons. In the SL equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h.

^c Instantaneous water heaters with input rates below 200,000 Btu/h must comply with these requirements if the water heater is designed to heat water to temperatures 180°F or higher.

Section 116 – Mandatory Requirements For Fenestration Products And Exterior Doors

NOTE: THIS SECTION OF THE STANDARD SPECIFIES HOW U-FACTORS AND SHGC SHALL BE CALCULATED FOR FENESTRATION PRODUCTS. IT IS MODIFIED TO PERMIT TABLE 5 FROM THE FENESTRATION CHAPTER OF THE ASHRAE 1997 FUNDAMENTALS HANDBOOK TO BE USED FOR SITE-BUILT WINDOWS IN BUILDINGS SMALLER THAN 100,000 FT² AND FOR ALL SKYLIGHTS.

- (a) **Certification of Fenestration Products and Exterior Doors.** Any fenestration product and exterior door, other than field-fabricated fenestration products and field-fabricated exterior doors, may be installed only if the manufacturer has certified to the commission, or if an independent certifying organization approved by the commission has certified, that the product complies with all of the applicable requirements of this subsection.
1. **Air leakage.** Manufactured fenestration products and exterior doors shall have air infiltration rates not exceeding 0.3 cfm/ft.² of window area, 0.3 cfm/ft.² of door area for residential doors, 0.3 cfm/ft.² of door area for nonresidential single doors (swinging and sliding), and 1.0 cfm/ft.² for nonresidential double doors (swinging), when tested according to NFRC-400-95 or ASTM E 283-91 at a pressure differential of 75 pascals or 1.57 pounds/ft.², incorporated herein by reference.
 2. **~~U-value~~U-factor and SHGC.** Fenestration products shall:
 - A. Be certified for overall ~~U-value~~U-factors as rated in accordance with the National Fenestration Rating Council's ~~NFRC 100-91 (1991)~~, or NFRC 100 (1997) and be certified for overall SHGC, as rated in accordance with the National Fenestration Rating Council's NFRC 200 (1995), incorporated herein by reference, or such values shall be certified in accordance with Tables 1-D and 1-E and labeled as a default table method set forth in Section 10-111; and
 - B. Have a temporary label or label certificate (for site built products) meeting the requirements of Section 10-111 (a) (1), not to be removed before inspection by the enforcement agency, listing the certified ~~U-value~~U-factor and SHGC, and certifying that the air infiltration requirements of Section 116 (a) 1 are met for each product line; and
 - C. Have a permanent label or label certificate (for site built products) meeting the requirements of Section 10-111 (a) (2) if the product is rated using NFRC procedures.

EXCEPTION to Section 116 (a): Fenestration products removed and reinstalled as part of a building alteration or addition.

EXCEPTION to Section 116 (a) 2: Glazed wall systems in buildings smaller than 100,000 ft² and overhead glazing in buildings covered by the nonresidential standards shall have SHGC and ~~U-values~~U-factors determined in accordance with NFRC procedures or default values set forth in ~~Section 116 (a) 2~~ the ASHRAE 1997 Fundamentals Handbook, Chapter 29, Table 5. Temporary and permanent labels are not required.

- (b) **Installation of Field-fabricated Fenestration Products and Exterior Doors.** Field-fabricated fenestration products and exterior doors shall be caulked between the fenestration products or exterior door and the building, and shall be weatherstripped.

EXCEPTION to Section 116 (b): Unframed glass doors and fire doors.

TABLE 1-D—DEFAULT FENESTRATION PRODUCT ~~U-VALUE~~U-FACTORS

FRAME TYPE ¹	PRODUCT TYPE	SINGLE PANE U-VALUE U- FACTOR	DOUBLE PANE U-VALUE U- FACTOR ²
Metal	Operable	1.28	0.87
Metal	Fixed	1.19	0.72
Metal	Greenhouse/garden window	2.26	1.40
Metal	Doors	1.25	0.85
Metal	Skylight	1.72	0.94
Metal, Thermal Break	Operable		0.71
Metal, Thermal Break	Fixed		0.60
Metal, Thermal Break	Greenhouse/garden window		1.12
Metal, Thermal Break	Doors		0.64
Metal, Thermal Break	Skylight		0.80
Nonmetal	Operable	0.99	0.60
Nonmetal	Fixed	1.04	0.57
Nonmetal	Doors	0.99	0.55
Nonmetal	Greenhouse/garden windows	1.94	1.06
Nonmetal	Skylight	1.47	0.68

¹ Metal includes any field-fabricated product with metal cladding. Nonmetal-framed manufactured fenestration products with metal cladding must add 0.04 to the listed ~~U-value~~U-factor. Nonmetal frame types can include metal fasteners, hardware, and door thresholds. Thermal break product design characteristics are:

- The material used as the thermal break must have a thermal conductivity of not more than 3.6 Btu-inch/hr./ft.²/°F,
- The thermal break must produce a gap of not less than 0.210 inch, and
- All metal members of the fenestration product exposed to interior and exterior air must incorporate a thermal break meeting the criteria in Items a. and b. above.

In addition, the fenestration product must be clearly labeled by the manufacturer that it qualifies as a thermally broken product in accordance with this standard.

²For all dual-glazed fenestration products, adjust the listed ~~U-value~~ U-factors as follows:

- a. Subtract 0.05 for spacers of 7/16 inch or wider.
- b. Subtract 0.05 for products certified by the manufacturer as low-E glazing.
- c. Add 0.05 for products with dividers between panes if spacer is less than 7/16 inch wide.
- d. Add 0.05 to any product with true divided lite (dividers through the panes).

TABLE 1-E—DEFAULT SOLAR HEAT GAIN COEFFICIENT

FRAME TYPE	PRODUCT	GLAZING	TOTAL WINDOW SHGC	
			Single Pane	Double Pane
Metal	Operable	Uncoated	0.80	0.70
Metal	Fixed	Uncoated	0.83	0.73
Metal	Operable	Tinted	0.67	0.59
Metal	Fixed	Tinted	0.68	0.60
Metal, Thermal Break	Operable	Uncoated	0.72	0.63
Metal, Thermal Break	Fixed	Uncoated	0.78	0.69
Metal, Thermal Break	Operable	Tinted	0.60	0.53
Metal, Thermal Break	Fixed	Tinted	0.65	0.57
Nonmetal	Operable	Uncoated	0.74	0.65
Nonmetal	Fixed	Uncoated	0.76	0.67
Nonmetal	Operable	Tinted	0.60	0.53
Nonmetal	Fixed	Tinted	0.63	0.55

SHGC = Solar Heat Gain Coefficient.

Section 119.5 – Mandatory Requirements for Cool Roofs

- (a) Effective January 1, 2003, a roof shall be considered a cool roof if the roof is certified and labelled according to requirements of Section 10-113 and if the roof meets conditions (1) or (2) below. Prior to January 1, 2003, manufacturer's published performance data shall be acceptable to show compliance with one of the following conditions.
- (1) Roof of concrete tile (per ASTM C55-99) and clay tile (per ASTM C1167-96) require a minimum initial total solar reflectance of 0.40 when tested in accordance with ASTM E903 or E1918, and a minimum thermal emittance of 0.75 when tested in accordance with ASTM E408.
- (2) All other roofs require a minimum initial total solar reflectance of 0.70 when tested in accordance with ASTM E903 or E1918, and a minimum thermal emittance of 0.75 when tested in accordance with ASTM E408.

Section 123 – Requirements For Pipe Insulation

The piping for all space-conditioning and service water-heating systems with fluid temperatures listed in Table 1-G shall have the amount of insulation specified in Subsection (a) or (b). Insulation conductivity shall be determined in accordance with ASTM C 335-95 at the mean temperature listed in Table 1-G, and shall be rounded to the nearest 1/100 Btu-inch per hour per square foot per °F.

Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind but not limited to the following:

Insulation exposed to weather shall be suitable for outdoor service; e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

Insulation covering chilled water piping, refrigerant suction piping located outside the conditioned space shall include a vapor retardant located outside the insulation (unless the insulation is inherently vapor retardant), all penetrations and joints of which shall be sealed.

EXCEPTION 1 to Section 123: Factory-installed piping within space-conditioning equipment certified under Section 111 or 112.

EXCEPTION 2 to Section 123: Piping that conveys fluids with a design operating temperature range between 60°F and 105°F.

EXCEPTION 3 to Section 123: Piping that serves process loads, gas piping, cold domestic water piping, condensate drains, roof drains, vents, or waste piping.

EXCEPTION 4 to Section 123: Where the heat gain or heat loss to or from piping without insulation will not increase building source energy use.

- (a) For insulation with a conductivity in the range shown in Table 1-G for the applicable fluid temperature range, the insulation shall have the applicable thickness shown in Table 1-G.

TABLE 1-G—PIPE INSULATION THICKNESS

FLUID TEMPERATURE RANGE, (°F)	CONDUCTIVIT YRANGE (in Btu-inch per hour per square foot per °F)	INSULATION MEAN RATING TEMPERATURE (°F)	NOMINAL PIPE DIAMETER (in inches)					
			Runouts up to 2	1 and less	1.25-2	2.50-4	5-6	8 and larger
			INSULATION THICKNESS REQUIRED (in inches)					
Space heating systems (steam, steam condensate and hot water)								
Above 350	0.32-0.34	250	1.5	2.5	2.5	3.0	3.5	3.5
251-350	0.29-0.31	200	1.5	2.0	2.5	2.5	3.5	3.5
201-250	0.27-0.30	150	1.0	1.5	1.5	2.0	2.0	3.5
141-200	0.25-0.29	125	0.5	1.5	1.5	1.5	1.5	1.5
105-140	0.24-0.28	100	0.5	1.0	1.0	1.0	1.5	1.5
Service water-heating systems (recirculating sections, all piping in electric trace tape systems, and the first 8 feet of piping from the storage tank for nonrecirculating systems)								
Above 105	0.24-0.28	100	0.5	1.0	1.0	1.5	1.5	1.5
Space cooling systems (chilled water, refrigerant and brine)								
40-60	0.23-0.27	75	0.5	0.5	0.5	1.0	1.0	1.0
Below 40	0.23-0.27	75	1.0	1.0	1.5	1.5	1.5	1.5

- (b) For insulation with a conductivity outside the range shown in Table 1-G for the applicable fluid temperature range, the insulation shall have a minimum thickness as calculated with Equation (1-A):

EQUATION (1-A)—INSULATION THICKNESS EQUATION

$$T = PR \left[\left(1 + \frac{t}{PR} \right)^{\frac{K}{k}} - 1 \right]$$

WHERE:

- T*** = Minimum insulation thickness for material with conductivity *K*, inches.
PR = Pipe actual outside radius, inches.
t = Insulation thickness from Table 1-G, inches.
K = Conductivity of alternate material at the mean rating temperature indicated in Table 1-G for the applicable fluid temperature range, in Btu-inch per hour per square foot per °F.
k = The lower value of the conductivity range listed in Table 1-G for the applicable fluid temperature range, Btu-inch per hour per square foot per °F.

Section 124 – Requirements For Air Distribution System Ducts And Plenums

- (a) **UMC Compliance.** All air distribution system ducts and plenums, including, but not limited to, building cavities, mechanical closets, air-handler boxes and support platforms used as ducts or plenums, shall be installed, sealed and insulated to meet the requirements of the 1997 UMC Sections 601, 603, 604, and Standard 6-3, incorporated herein by reference. Portions conveying conditioned air shall either be insulated to a minimum installed level of R-4.2 (or any higher level required by UMC Section 604) or be enclosed entirely in conditioned space. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened. Openings shall be sealed with mastic, tape, aerosol sealant, or other duct-closure system that meets the applicable requirements of UL 181, UL 181A, or UL 181B. If mastic or tape is used to seal openings greater than 1/4 inch, the combination of mastic and either mesh or tape shall be used.
- (b) **Duct and Plenum Materials.**
1. **Factory-fabricated duct systems.**
 - A. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections and splices, and be UL labeled.
 - B. All pressure-sensitive tapes, heat-activated tapes, and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181.
 - A. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 or UL 181B.
 2. **Field-fabricated duct systems.**
 - A. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants, or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A, or UL 181B.
 - B. **Mastic sealants and mesh.**
 - i. Sealants shall comply with UL 181, UL 181A, or UL 181B, and be nontoxic and water resistant.
 - ii. Sealants for interior applications shall pass ASTM tests C 731 (extrudability after aging) and D 2202 (slump test on vertical surfaces), incorporated herein by reference.

- iii. Sealants for exterior applications shall pass ASTM tests C 731, C 732 (artificial weathering test), and D 2202, incorporated herein by reference.
 - iv. Sealants and meshes shall be rated for exterior use.
- C. **Pressure-sensitive tape.** Pressure-sensitive tapes shall comply with UL 181, UL 181A, or UL 181B.
- D. **Drawbands used with flexible duct.**
- i. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.
 - ii. Drawbands shall have a minimum tensile strength rating of 150 pounds.
 - iii. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.
- E. **Aerosol-sealant closures.**
- i. Aerosol sealants shall meet the applicable requirements of UL 181, 181A, or 181B and be applied according to manufacturer specifications.
 - ii. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.

(c) Protection of insulation

Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind but not limited to the following:

1. Insulation exposed to weather shall be suitable for outdoor service; e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.
2. Insulation covering cooling ducts located outside the conditioned space shall include a vapor retardant located outside the insulation (unless the insulation is inherently vapor retardant), all penetrations and joints of which shall be sealed.

Section 130 – Lighting Systems And Equipment— General

- (a) Except as provided in Subsection (b), the design and installation of all lighting systems and equipment in nonresidential, high-rise residential, and hotel/motel buildings subject to Title 24, Part 6, shall comply with the applicable provisions of Sections 131 through 139.
- (b) The design and installation of all lighting systems and equipment in high-rise residential living quarters and in hotel/motel guest rooms shall comply with the following:

1. Luminaires for general lighting in kitchens shall have lamps with an efficacy of not less than 40 lumens per watt. A luminaire which is the only lighting in a kitchen will be considered general lighting. General lighting shall be controlled by the most accessible switch(es) in the kitchen.

Additional luminaires to be used only for specific decorative effects need not meet this requirement.

2. Each room containing a water closet shall have at least one luminaire with lamps with an efficacy of not less than 40 lumens per watt. If there is more than one luminaire in the room, the high efficacy luminaire shall be switched at an entrance to the room. The efficacy requirement may be met by installing the luminaire meeting this requirement in an adjacent room that has complementary plumbing fixtures.
3. Luminaires installed to meet the 40 lumens per watt requirements of Subsection 1 or 2 shall not contain medium base incandescent lamp sockets, and shall be on separate switches from any incandescent lighting.
4. All incandescent lighting fixtures recessed into insulated ceilings shall be approved for zero-clearance insulation cover (IC) by Underwriters Laboratories or other testing/rating laboratories recognized by the International Conference of Building Officials.

EXCEPTION to Section 130 (b): Up to 10 percent of the guest rooms in a hotel/motel need not comply.

- (c) Exterior Building Lighting. All permanently installed exterior luminaires attached to, or powered by the electrical service of conditioned or semi-conditioned buildings, and employing lamps rated over 100 watts shall either:

1. Have a source efficacy, determined by dividing the rated initial lamp lumens by the rated lamp watts, of at least 60 lumens per watt; or
2. Be controlled by a motion sensor or programmable time controller that limits lamp use to no more than 60 minutes per start

EXCEPTION 1 to Section 130 (c): Lighting required by a health or life safety statute, ordinance, or regulation, including, but not limited to emergency lighting.

EXCEPTION 2 to Section 130 (c): Lighting that is integral to advertising signage.

EXCEPTION 3 to Section 130 (c): Lighting used in or around swimming pools, water features, or other locations subject to Article 680 of the California Electric Code

EXCEPTION 4 to Section 130 (c): Searchlights and lighting for use in theme parks.

EXCEPTION 5 to Section 130 (c): Outdoor theatrical equipment, provided it is for temporary or periodic use and is not for continuous use.

(d) Luminaire wattage incorporated into the installed interior lighting power shall be determined in accordance with the following criteria:

1. the wattage of incandescent or tungsten-halogen luminaires with medium screw base sockets and not containing permanently installed ballasts shall be the maximum labeled wattage of the luminaire.
2. the wattage of luminaires with permanently installed or remotely installed ballasts shall be the operating input wattage of the specified lamp/ballast combination based on values from manufacturers catalogs or values from independent testing lab reports.
3. the wattage of line-voltage lighting track and plug-in busway that allow the addition and/or relocation of luminaires without altering the wiring of the system shall be the specified wattage of the luminaires included in the system with a minimum of 30 W/lin ft (98 W/lin m).
4. the wattage of low-voltage lighting track, cable conductor, rail conductor, and other flexible lighting systems that allow the addition and/or relocation of luminaires without altering the wiring of the system shall be the specified wattage of the transformer supplying the system.
5. the wattage of all other miscellaneous lighting equipment shall be the specified wattage of the lighting equipment.

Section 131 – Lighting Controls That Must Be Installed

(a) Area Controls.

1. Each area enclosed by ceiling-height partitions shall have an independent switching or control device. This switching or control device shall be:
 - A. Readily accessible; and
 - B. Located so that a person using the device can see the lights or area controlled by that switch, or so that the area being lit is annunciated; and
 - C. Manually operated, or automatically controlled by an occupant-sensing device that meets the requirements of Section 119 (d).
2. Other devices may be installed in conjunction with the switching or control device provided that they:
 - A. Permit the switching or control device to override the action of all other devices; and
 - B. Reset the mode of any automatic system to normal operation without further action.

EXCEPTION 1 to Section 131 (a): Up to one-half watt per square foot of lighting in any area within a building that must be continuously illuminated for reasons of building security or emergency egress, if:

- A. The area is designated a security or emergency egress area on the plans and specifications submitted to the enforcement agency under Section 10-103 (a) (2) of Title 24, Part 1; and
- B. The area is controlled by switches accessible only to authorized personnel.

EXCEPTION 2 to Section 131 (a): Public areas with switches that are accessible only to authorized personnel.

(b) Controls to Reduce Lighting. The general lighting of any enclosed space 100 square feet or larger in which the connected lighting load exceeds ~~1.00~~0.8 watts per square foot for the space as a whole, and that has more than one light source (luminaire), shall be controlled so that the load for the lights may be reduced by at least one half while maintaining a reasonably uniform level of illuminance throughout the area. A reasonably uniform reduction of illuminance shall be achieved by:

1. Controlling all lamps or luminaires with dimmers; or
2. Dual switching of alternate rows of luminaires, alternate luminaires, or alternate lamps; or
3. Switching the middle lamps of three lamp luminaires independently of the outer lamps; or

4. Switching each luminaire or each lamp.

~~**EXCEPTION 1 to Section 131 (b):** Lights in areas that are controlled by an occupant sensing device that meets the requirements of Section 119 (d).~~

EXCEPTION 2 to Section 131 (b): Lights in corridors.

~~**EXCEPTION 3 to Section 131 (b):** Lights in areas that are controlled by an automatic time switch control device that has a timed manual override available at each switch location required by Section 131 (a) and that controls only the lights in the area enclosed by ceiling height partitions.~~

(c) **Daylit Areas.** Daylit areas in any enclosed space greater than 250 square feet shall meet the requirements of Items 1 and 2 below

1. Such areas shall have at least one control that:

- A. Controls only luminaires in the daylit area; and
- B. Controls at least 50 percent of the lamps or luminaires in the daylit area, in a manner described in Section 131 (b) 1 through 4, independently of all other lamps or luminaires in the enclosed space. The other luminaires in the enclosed space may be controlled in any manner allowed by Section 131 (b) 1 through 4.

2. Such areas shall have controls that control the luminaires in each vertically daylit area separately from the luminaires in each horizontally daylit area.

EXCEPTION 1 to Section 131 (c): Daylit areas where the effective aperture of glazing is equal to or less than 0.1 for vertical glazing and 0.01 for horizontal glazing.

EXCEPTION 2 to Section 131 (c): Daylit areas where existing adjacent structures or natural objects obstruct daylight to the extent that effective use of daylighting is not feasible.

(d) **Shut-off Controls.**

1. For every floor, all interior lighting systems shall be equipped with a separate automatic control to shut off the lighting. This automatic control shall meet the requirements of Section 119 and may be an occupancy sensor, automatic time switch, or other device capable of automatically shutting off the lighting.

~~**EXCEPTION 1 to Section 131 (d) 1:** Buildings or separately metered spaces of less than 5,000 square feet of conditioned space.~~

~~**EXCEPTION 21 to Section 131 (d) 1:** Where the system is serving an area that must be continuously lit, or lit in a manner requiring manual operation of the lighting.~~

~~**EXCEPTION 32 to Section 131 (d) 1:** Lighting in corridors, guest rooms, and lodging quarters of high-rise residential buildings and hotel/motels.~~

~~**EXCEPTION 43 to Section 131 (d) 1:** Up to one-half watt per square foot of lighting in any area within a building that must be continuously illuminated for reasons of building security or emergency egress, if:~~

- A. The area is designated a security or emergency egress area on the plans and specifications submitted to the enforcement agency under Section 10-103 (a) 2 A of Title 24, Part 1; and
 - B. The area is controlled by switches accessible only to authorized personnel.
2. If an automatic time switch control device is installed to comply with Section 131 (d) 1, it shall incorporate an override switching device that:
- A. Is readily accessible; and
 - B. Is located so that a person using the device can see the lights or the area controlled by that switch, or so that the area being lit is annunciated; and
 - C. Is manually operated; and
 - D. Allows the lighting to remain on for no more than two hours when an override is initiated; and
 - E. Controls an area not exceeding 5,000 square feet.

EXCEPTION to Section 131 (d) 2 D: In malls and arcades, auditoriums, single tenant retail spaces, industrial facilities, and arenas, where captive-key override is utilized, override time may exceed two hours.

EXCEPTION to Section 131 (d) 2 E: In malls and arcades, auditoriums, single tenant retail spaces, industrial facilities, and arenas, the area controlled may not exceed 20,000 square feet.

3. If an automatic time switch control device is installed to comply with Section 131 (d) 1, it shall incorporate an automatic holiday "shut-off" feature that turns off all loads for at least 24 hours, then resumes the normally scheduled operation.

EXCEPTION to Section 131 (d) 3: Retail stores and associated malls, restaurants, grocery stores, churches, and theaters.

- (e) **Display Lighting.** Display lighting shall be separately switched on circuits that are 20 amps or less.
- (f) **Exterior Lighting.** Exterior lighting controlled from a lighting panel within the building shall be controlled by a directional photocell or astronomical time switch that automatically turns off the exterior lighting when daylight is available.

EXCEPTION to Section 131 (f): Lighting in parking garages, tunnels, and large covered areas that require illumination during daylight hours.

Section 143 – Prescriptive Requirements For Building Envelopes

A building complies with this section by being designed with and having constructed and installed either (1) envelope components that comply with each of the requirements in Subsection (a) for each individual component, or (2) an envelope that complies with the overall requirements in Subsection (b). When making calculations under Subsection (a) or (b), all of the rules listed in Section 141 (c) 1, 4, and 5 shall apply.

(a) **Envelope Component Approach.**

1. **Exterior roofs and ceilings.** Exterior roofs and ceilings shall have either an installed insulation R-value no less than, or an overall assembly U-value no greater than, the applicable value in Table 1-H or 1-I.
2. **Exterior walls.** Exterior walls shall have either an installed insulation R-value no less than, or an overall assembly U-value no greater than, the applicable value in Table 1-H or 1-I.
3. **Demising walls.** The opaque portions of framed demising walls in nonresidential buildings shall have insulation with an installed insulation R-value no less than R-11 between framing members.
4. **External floors and soffits.** External floors and soffits shall have either an installed insulation R-value no less than, or an overall assembly U-value no greater than, the applicable value in Table 1-H or 1-I.
5. **Windows.** Windows shall:
 - A. Have an area no greater than 40 percent of the gross exterior wall area, or six feet times the display perimeter, whichever is greater; and

EXCEPTION to 143 (a) 5 A: Window area in demising walls is not counted as part of the window area for this requirement. Demising wall area is not counted as part of the gross exterior wall area or display perimeter.
 - B. Have a U-value no greater than the applicable value in Table 1-H or 1-I; and
 - C. Have a relative solar heat gain, excluding the effects of interior shading, no greater than the applicable value in Table 1-H or 1-I. The relative solar heat gain of windows is:
 - i. The solar heat gain coefficient of the windows; or

- ii. Relative solar heat gain as calculated by Equation (1-B), if an overhang extends beyond both sides of the window jamb a distance equal to the overhang projection.

EXCEPTION to Section 143 (a) 5 C: The applicable "north" value for relative solar heat gain in Table 1-H or 1-I or 0.56, which ever is greater, shall be used for windows:

- A. That are in the first story of exterior walls that form a display perimeter; and
- B. For which codes restrict the use of overhangs to shade the windows.

EQUATION (1-B)—RELATIVE SOLAR HEAT GAIN EQUATION

$$RSHG = SHGC_{win} \times \left[1 + \frac{aH}{V} + b \left(\frac{H}{V} \right)^2 \right]$$

WHERE:

- $RSHG$ = Relative solar heat gain.
- $SHGC_{win}$ = Solar heat gain coefficient of the window.
- H = Horizontal projection of the overhang from the surface of the window in feet, but no greater than V .
- V = Vertical distance from the window sill to the bottom of the overhang, in feet.
- a = -0.41 for north-facing windows, -1.22 for south-facing windows, and -0.92 for east- and west-facing windows.
- b = 0.20 for north-facing windows, 0.66 for south-facing windows, and 0.35 for east- and west-facing windows.

6. Skylights. Skylights shall:

- A. Have an area no greater than five percent of the gross exterior roof area; and

EXCEPTION to Section 143 (a) 6 A: Atria over 55 feet high shall have a skylight area no greater than 10 percent of the gross exterior roof area.

- B. Have a U-value no greater than the applicable value in Table 1-H or 1-I; and
- C. Have a solar heat gain coefficient no greater than the applicable value in Table 1-H or 1-I.

7. Exterior doors. Exterior doors have no R-value, U-value, or area requirements.

**TABLE 1-H—PRESCRIPTIVE ENVELOPE CRITERIA
FOR NONRESIDENTIAL BUILDINGS**
(Except high-rise residential buildings and guest rooms of hotel/motel buildings)

		CLIMATE ZONES									
		1,16		23-5		6-109		2,1011-13		14, 15	
Roof/Ceiling											
R-value or		19		19		11		19		19	
U-value		0.057		0.057		0.078		0.057		0.057	
Wall											
R-value or		13		11		11		13		13	
U-value											
Wood frame		0.084		0.092		0.092		0.084		0.084	
Metal frame		0.182		0.189		0.189		0.182		0.182	
Mass/7.0≤ HC<15.0		0.340		0.430		0.430		0.430		0.430	
Mass/15.0≤HC		0.360		0.650		0.690		0.650		0.400	
Other		0.084		0.092		0.092		0.084		0.084	
Floor/Soffit											
R-value or		19		11		11		11		11	
U-value											
Mass/7.0≤HC		0.097		0.158		0.158		0.097		0.158	
Other		0.050		0.076		0.076		0.076		0.076	
Windows											
U-value		0.720.49		1.230.81		1.230.81		0.720.49		0.720.49	
Relative solar heat gain											
North		0.77		0.82		0.82		0.77		0.77	
Nonnorth		0.50		0.62		0.62		0.50		0.50	
		Non-North	North	Non-North	North	Non-North	North	Non-North	North	Non-North	North
0-10% WWR		0.49	0.72	0.61	0.61	0.61	0.61	0.47	0.61	0.46	0.61
11-20% WWR		0.43	0.49	0.55	0.61	0.61	0.61	0.36	0.51	0.36	0.51
21-30% WWR		0.43	0.47	0.41	0.61	0.39	0.61	0.36	0.47	0.36	0.47
31-40% WWR		0.43	0.47	0.41	0.61	0.34	0.61	0.31	0.47	0.31	0.40
Skylights											
U-value		0.85		1.31		1.31		0.85		0.85	
Solar heat gain coefficient											
Transparent		0.44		0.61		0.61		0.44		0.44	
Translucent		0.70		0.75		0.75		0.70		0.70	
U-factor	Glass w/Curb	0.99		1.18		1.18		0.99		0.99	
	Glass wo/Curb	0.57		0.68		0.68		0.57		0.57	
	Plastic w/Curb	0.87		1.30		1.30		1.10		1.10	
SHGC	0-2%	0.68		0.79		0.79		0.46		0.46	
Glass	2.1-5%	0.46		0.40		0.40		0.36		0.36	
SHGC	0-2%	0.77		0.79		0.77		0.77		0.71	
Plastic	2.1-5%	0.58		0.65		0.62		0.62		0.58	

**TABLE 1-I—PRESCRIPTIVE ENVELOPE CRITERIA FOR HIGH-RISE
RESIDENTIAL BUILDINGS AND GUEST ROOMS
OF HOTEL/MOTEL BUILDINGS**

		CLIMATE ZONES									
		1, 16		23-5		6-109		11-10-13		14, 15	
Roof/Ceiling											
R-value or		30		19		19		30		30	
U-value		0.037		0.051		0.051		0.037		0.037	
Wall											
R-value or		19		11		11		13		13	
U-value											
Wood frame		0.063		0.092		0.092		0.084		0.084	
Metal frame		0.140		0.181		0.181		0.175		0.175	
Mass/7.0≤ HC<15.0		0.340		0.430		0.430		0.430		0.430	
Mass/15.0≤HC		0.360		0.650		0.690		0.650		0.400	
Other		0.063		0.092		0.092		0.084		0.084	
Floor/Soffit											
R-value or		19		11		11		11		11	
U-value											
Mass/7.0≤HC		0.097		0.158		0.158		0.097		0.097	
Other		0.050		0.076		0.076		0.076		0.076	
Raised concrete R-value		8		*		*		*		*	
Windows											
U-value		0.720.49		1.230.49		1.230.49		0.720.49		0.720.49	
Relative solar heat gain											
—North		0.77		0.82		0.82		0.77		0.77	
—Nonnorth		0.77		0.82		0.62		0.50		0.50	
		Non-	North	Non-	North	Non-	North	Non-	North	Non-	North
		North		North		North		North		North	
0-10% WWR		0.46	0.68	0.41	0.61	0.47	0.61	0.36	0.49	0.36	0.47
11-20% WWR		0.46	0.68	0.40	0.61	0.40	0.61	0.36	0.49	0.31	0.43
21-30% WWR		0.36	0.47	0.31	0.61	0.36	0.61	0.31	0.40	0.26	0.43
31-40% WWR		0.30	0.47	0.26	0.55	0.31	0.61	0.26	0.40	0.26	0.31
Skylights											
U-value		0.85		1.31		1.31		0.85		0.85	
Solar heat gain coefficient											
—Transparent		0.44		0.61		0.61		0.44		0.44	
—Translucent		0.70		0.75		0.75		0.70		0.70	
U-factor	Glass w/Curb	0.99		1.18		1.18		0.99		0.99	
	Glass wo/Curb	0.57		0.68		0.68		0.57		0.57	
	Plastic w/Curb	0.87		1.30		1.30		1.10		0.87	
SHGC	0-2%	0.46		0.58		0.61		0.46		0.46	
Glass	2.1-5%	0.36		0.32		0.40		0.32		0.31	
SHGC	0-2%	0.71		0.65		0.65		0.65		0.65	
Plastic	2.1-5%	0.55		0.39		0.65		0.34		0.27	

* Required insulation levels for concrete raised floors are R-8 in Climate Zones 2, 11, 13, and 14;
R-4 in Climate Zones 12 and 15, and R-0 in Climate Zones 3 through 10.

- (b) **Overall heat gain.** The overall heat gain of the overall envelope of the proposed building, HG_{prop} as calculated with Equation (1-F), shall be no greater than the overall heat gain of the overall envelope of a standard building, HG_{std} as calculated with Equation (1-E). In making the calculations, it shall be assumed that the orientation and area of each envelope component of the standard building are the same as in the proposed building.

EQUATION (1-E)—STANDARD BUILDING HEAT GAIN EQUATION

$$\begin{aligned}
 HG_{std} = & \sum_{i=1}^{nW} (A_{Wi} \times U_{Wi_{std}} \times TF_i) + \sum_{i=1}^{nF} (A_{Fi} \times U_{Fi_{std}} \times TF_i) + \sum_{i=1}^{nR} (A_{Ri} \times U_{Ri_{std}} \times TF_i) \\
 & + \sum_{i=1}^{nG} (A_{Gi} \times U_{Gi_{std}} \times TF_i) + \sum_{i=1}^{nS} (A_{Si} \times U_{Si_{std}} \times TF_i) + \sum_{i=1}^{nG} (WF_{Gi} \times A_{Gi} \times RSHG_{Gi_{std}}) \times SF \\
 & + \sum_{i=1}^{nS} (WF_{Si} \times A_{Si} \times SHGC_{Si_{std}}) \times SF + \sum_{i=1}^{nR} (WF_{Ri} \times A_{Ri} \times U_{Ri_{std}} \times \alpha_{Ri_{std}}) \times SF
 \end{aligned}$$

NOTE: EQUATION (1-E) HAS BEEN CHANGED

WHERE:

HG_{std} = Overall heat gain of the standard building (Btu/h).

i = As determined in Equation 1-C.

$nW, nR,$
 $nG, nF,$
 nS = As determined in Equation 1-C.

A_{Wi} = As determined in Equation 1-C.

A_{Fi} = As determined in Equation 1-C.

A_{Ri} = As determined in Equation 1-C.

A_{Gi} = As determined in Equation 1-C.

A_{Si} = As determined in Equation 1-C.

U_{Wstd} = As determined in Equation 1-C.

U_{Fstd} = As determined in Equation 1-C.

U_{Rstd} = As determined in Equation 1-C.

U_{Gstd} = As determined in Equation 1-C.

U_{Sstd} = As determined in Equation 1-C.

$RSHG_{Gstd}$	=	The applicable relative solar heat gain for the corresponding A_{Gi} , from Table 1-H or 1-I (unitless).
$W_n, W_e,$ W_s, WF_{Gi}	=	The applicable weighting factor for each orientation of the standard building, from Table 1-K (unitless).
WF_{Si}	=	The applicable weighting factor for skylight of the standard building, from Table 1-K (unitless).
<u>WF_{Si}</u>	=	<u>The applicable weighting factor for roof of the standard building, from Table 1-K (unitless).</u>
<u>α_{Rstd}</u>	=	<u>A standard roof absorptivity 0.70 for the corresponding A_{Ri}.</u>
$SHGC_{Sstd}$	=	The applicable solar heat gain coefficient for the corresponding A_{Si} , from Table 1-H or 1-I (unitless).
SF	=	The solar factor from Table 1-J.
TF_i	=	The temperature factor from Table 1-J.

EQUATION (1-F)—PROPOSED BUILDING HEAT GAIN EQUATION

$$\begin{aligned}
 HG_{prop} = & \sum_{j=1}^{nW} (A_{Wj} \times U_{Wjprop} \times TF_j) + \sum_{j=1}^{nF} (A_{Fj} \times U_{Fjprop} \times TF_j) + \sum_{j=1}^{nR} (A_{Rj} \times U_{Rjprop} \times TF_j) \\
 & + \sum_{j=1}^{nG} (A_{Gj} \times U_{Gjprop} \times TF_j) + \sum_{j=1}^{nS} (A_{Sj} \times U_{Sjprop} \times TF_j) + \sum_{j=1}^{nG} (WF_{Gj} \times A_{Gj} \times SHGC_{Gjprop} \times OHF_j) \times SF \\
 & + \sum_{j=1}^{nS} (WF_{Sj} \times A_{Sj} \times SHGC_{Sjprop}) \times SF + \sum_{j=1}^{nR} (WF_{Rj} \times A_{Rj} \times U_{Rjprop} \times \alpha_{Rjprop}) \times SF
 \end{aligned}$$

NOTE: EQUATION (1-F) HAS BEEN CHANGED

WHERE:

HG_{prop} = Overall heat gain of the proposed building (Btu/h).

j = As determined in Equation 1-D.

$nW, nR,$
 $nG, nF,$
 nS = As determined in Equation 1-D.

A_{Wj} = As determined in Equation 1-D.

A_{Fj} = As determined in Equation 1-D.

A_{Rj} = As determined in Equation 1-D.

A_{Gj} = As determined in Equation 1-D.

A_{Sj} = As determined in Equation 1-D.

U_{Wjprop} = As determined in Equation 1-D.

U_{Fjprop} = As determined in Equation 1-D.

U_{Rjprop} = As determined in Equation 1-D.

U_{Gjprop} = As determined in Equation 1-D.

U_{Sjprop} = As determined in Equation 1-D.

$SHGC_{Gj}$ = The solar heat gain coefficient for the corresponding A_{Gj} (unitless)

$SHGC_{Sj}$ = The solar heat gain coefficient for the corresponding A_{Sj} (unitless).

OHF_{Gj} = The overhang factor for the corresponding A_{Gj} (unitless).

$$OHF_{Gj} = 1 + aH/V + b(H/V)^2$$

WHERE:

H = Horizontal projection of an overhang from the surface of the window, no greater than V , in feet.

V = Vertical distance from the window sill to the bottom of the overhang, in feet.

a = -0.41 for north-facing windows, -1.22 for south-facing windows, and -0.92 for east- and west-facing windows.

b = 0.20 for north-facing windows, 0.66 for south-facing windows, and 0.35 for east- and west-facing windows.

WF_{Gj} = The applicable weighting factor for each orientation of the building, from Table 1-K (unitless).

WF_{Sj} = The applicable weighting factor for skylight of the proposed building, from Table 1-K (unitless).

WF_{Rj} = The applicable weighting factor for roof of the proposed building, from Table 1-K (unitless).

α_{Rjstd} = The applicable roof absorptivity for the corresponding A_{Rj} . An absorptivity of 0.45 for cool roofs (as defined in Section 119.5). An absorptivity of 0.7 for all other roofs.

SF = The solar factor from Table 1-J.

TF_j = The temperature factor from Table 1-J.

TABLE 1-J—TEMPERATURE AND SOLAR FACTORS

CLIMATE ZONE	TEMPERATURE FACTOR (TF) Envelope Construction			SOLAR FACTOR (SF) (Btu/hr. x ft. ²)
	Light Mass	Medium Mass	Heavy Mass	
1	14	3	1	128
2	40	30	28	126
3	28	18	16	126
4	32	22	20	125
5	27	17	15	124
6	28	18	16	123
7	27	17	15	123
8	33	23	21	123
9	42	31	29	123
10	45	35	33	123
11	49	38	36	127
12	45	34	32	126
13	45	35	33	125
14	52	42	40	125
15	55	45	43	123
16	34	23	21	128

Light Mass: Heat Capacity < 7 Btu/ft.²-°F

Medium Mass: Heat Capacity ≥ 7 and <15 Btu/ft.²-°F

Heavy Mass: Heat Capacity ≥ 15 Btu/ft.²-°F

TABLE 1-K—GLAZING ORIENTATION WEIGHTING FACTORS (WF_G) & (WF_S)

		CLIMATE ZONES				
		1,16	2-5	6-10	11-13	14,15
North		0.63	0.52	0.34	0.42	0.67
East		1.14	1.05	1.02	1.27	1.08
South		0.99	1.24	1.31	1.14	1.12
West		1.24	1.19	1.34	1.17	1.13
Skylight		2.54	2.74	2.30	2.54	2.45
Climate Zone	WF _{north}	WF _{south}	WF _{west}	WF _{east}	WF _{sky}	WF _{roof}
NON-RESIDENTIAL						
1	0.56	1.25	1.16	1.03	1.48	0.93
2	0.56	1.30	1.18	0.96	2.34	1.12
3	0.51	1.28	1.24	0.97	2.42	0.84
4	0.55	1.20	1.24	1.01	2.53	0.96
5	0.58	1.25	1.18	0.98	2.48	0.80
6	0.56	1.23	1.21	1.00	2.40	0.84
7	0.57	1.30	1.17	0.97	2.36	0.87
8	0.60	1.26	1.14	1.00	2.47	0.98
9	0.56	1.36	1.11	0.97	2.29	0.97
10	0.60	1.38	1.07	0.95	2.19	1.02
11	0.55	1.19	1.17	1.10	2.37	0.89
12	0.55	1.17	1.21	1.07	2.40	0.92
13	0.58	1.15	1.17	1.10	2.39	1.04
14	0.57	1.17	1.20	1.07	2.46	1.13
15	0.61	1.27	1.05	1.07	2.29	0.92
16	0.51	1.27	1.15	1.07	2.20	1.03
HIGH-RISE RESIDENTIAL						
1	0.50	1.24	1.23	1.03	1.36	0.82
2	0.55	1.29	1.23	0.94	2.30	1.08
3	0.47	1.28	1.29	0.96	2.42	0.80
4	0.54	1.17	1.33	0.96	2.53	0.96
5	0.49	1.28	1.25	0.97	2.48	0.77
6	0.55	1.20	1.26	0.99	2.37	0.79
7	0.55	1.28	1.21	0.96	2.37	0.88
8	0.57	1.26	1.20	0.97	2.44	0.96
9	0.53	1.39	1.14	0.94	2.24	0.93
10	0.59	1.34	1.12	0.94	1.92	1.00
11	0.53	1.14	1.27	1.06	2.23	0.88
12	0.55	1.14	1.29	1.03	2.31	0.91
13	0.57	1.12	1.27	1.05	2.27	1.02
14	0.57	1.13	1.28	1.02	2.38	1.08
15	0.59	1.26	1.12	1.03	2.26	0.90
16	0.49	1.24	1.25	1.01	2.02	0.95

Section 144 – Prescriptive Requirements For Space-Conditioning Systems

A building complies with this section by being designed with and having constructed and installed a space-conditioning system that meets the requirements of Subsections (a) through (g).

- (a) **Sizing and Equipment Selection.** Mechanical heating and mechanical cooling equipment shall be the smallest size, within the available options of the desired equipment line, necessary to meet the design heating and cooling loads of the building, as calculated according to Subsection (b).

EXCEPTION 1 to Section 144 (a): Where it can be demonstrated to the satisfaction of the enforcing agency that oversizing will not increase building source energy use.

EXCEPTION 2 to Section 144 (a): Standby equipment with controls that allow the standby equipment to operate only when the primary equipment is not operating.

EXCEPTION 3 to Section 144 (a): Multiple units of the same equipment type, such as multiple chillers and boilers, having combined capacities exceeding the design load, if they have controls that sequence or otherwise optimally control the operation of each unit based on load.

- (b) **Calculations.** In making equipment sizing calculations under Subsection (a), all of the following rules shall apply:
1. **Methodology.** The methodologies, computer programs, inputs, and assumptions approved by the commission shall be used.
 2. **Heating and cooling loads.** Heating and cooling system design loads shall be determined in accordance with the procedures described in the ASHRAE Handbook, 1993, Fundamentals Volume, or as specified in a method approved by the commission.
 3. **Indoor design conditions.** Indoor design temperature and humidity conditions for general comfort applications shall be determined in accordance with ANSI/ASHRAE 55-1992 or Chapter 8 of the ASHRAE Handbook, 1993, Fundamentals Volume, except that winter humidification and summer dehumidification shall not be required.
 4. **Outdoor design conditions.** Outdoor design conditions shall be selected from ASHRAE publication SPCDX: Climatic Data for Region X, Arizona, California, Hawaii, and Nevada, 1982. Heating design temperatures shall be no lower than the temperature listed in the Winter Median of Extremes column. Cooling design dry bulb temperatures shall be no greater than the temperature listed in the Summer Design Dry Bulb 0.5 percent column. Cooling design wet bulb temperatures shall be no greater than the temperature listed in the Summer Design Wet Bulb 0.5 percent column.
 5. **Ventilation.** Outdoor air ventilation loads shall be calculated using the ventilation rates required in Section 121.

6. **Envelope.** Envelope heating and cooling loads shall be calculated using envelope characteristics, including square footage, thermal conductance, solar heat gain coefficient or shading coefficient, and air leakage, consistent with the proposed design.
 7. **Lighting.** Lighting loads shall be based on actual design lighting levels or power densities consistent with Section 146.
 8. **People.** Occupant density shall be based on the expected occupancy of the building and shall be the same as determined under Section 121 (b) 2 B, if used. Sensible and latent heat gains shall be as listed in ASHRAE Handbook, 1993, Fundamentals Volume, Chapter 26, Table 3.
 9. **Process loads.** Loads caused by a process shall be based upon actual information on the intended use of the building.
 10. **Miscellaneous equipment.** Equipment loads shall be calculated using design data compiled from one or more of the following sources:
 - A. Actual information based on the intended use of the building; or
 - B. Published data from manufacturer's technical publications and from technical societies, such as the ASHRAE Handbook, 1995; HVAC Applications Volume; or
 - C. Other data based on the designer's experience of expected loads and occupancy patterns.
 11. **Internal heat gains.** Internal heat gains may be ignored for heating load calculations.
 12. **Safety factor.** Design loads may be increased by up to 10 percent to account for unexpected loads or changes in space usage.
 13. **Other loads.** Loads such as warm-up or cool-down shall be calculated from principles based on the heat capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be no more than 30 percent for heating and 10 percent for cooling of the steady-state design loads. The steady-state load may include a safety factor in accordance with Section 144 (b) 12.
- (c) **Power Consumption of Fans.** Each fan system used for comfort space conditioning with a total fan power index over 25 horsepower shall meet the requirements of Item 1 or 2 below, as applicable. Total fan system power demand equals the sum of the power demand of all fans in the system that are required to operate at design conditions in order to supply air from the heating or cooling source to the conditioned space, and to return it back to the source or to exhaust it to the outdoors; however, total fan system power demand need not include the additional power demand caused solely by air treatment or filtering systems with final pressure drops more than

one-inch water column (only the energy accounted for by the amount of pressure drop that is over one inch may be excluded), or fan system power caused solely by process loads.

1. **Constant volume fan systems.** The total fan power index of each fan system at design conditions shall not exceed 0.8 watts per cfm of supply air.
2. **Variable air volume (VAV) systems.**
 - A. The total fan power index of each fan system at design conditions shall not exceed 1.25 watts per cfm of supply air; and
 - B. Individual VAV fans with motors over 25 horsepower shall meet one of the following:
 - i. The fan motor shall be driven by a mechanical or electrical variable speed drive.
 - ii. The fan shall be a vane-axial fan with variable pitch blades.
 - iii. For prescriptive compliance, the fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume when static pressure set point equals 1/3 of the total design static pressure, based on certified manufacturer's test data.
3. **Air-treatment or filtering systems.** For systems with air-treatment or filtering systems, calculate the adjusted fan power index using the following equation:

$$\text{Adjusted fan power index} = \text{Fan power index} \times \text{Fan Adjustment}$$

$$\text{Fan Adjustment} = 1 - \left(\frac{SP_a}{SP_f} \right)$$

WHERE:

SP_a = Air pressure drop across the air-treatment or filtering system.

SP_f = Total pressure drop across the fan.

- (d) **Space-conditioning Zone Controls.** Each space-conditioning zone shall have controls that prevent:
 1. Reheating; and
 2. Recooling; and

3. Simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by cooling equipment or by economizer systems.

EXCEPTION 1 to Section 144 (d): Zones served by a variable air-volume system that is designed and controlled to reduce, to a minimum, the volume of reheated, recooled, or mixed air supply. For each zone, this minimum volume shall be no greater than the largest of the following:

- A. 30 percent of the peak supply volume; or
- B. The minimum required to meet the ventilation requirements of Section 121; or
- C. 0.4 cubic feet per minute (cfm) per square foot of conditioned floor area of the zone; or
- D. 300 cfm.

EXCEPTION 2 to Section 144 (d): Zones with special pressurization relationships or cross-contamination control needs.

EXCEPTION 3 to Section 144 (d): Zones served by space-conditioning systems in which at least 75 percent of the energy for reheating, or providing warm air in mixing systems, is provided from a site-recovered or site-solar energy source.

EXCEPTION 4 to Section 144 (d): Zones in which specific humidity levels are required to satisfy process needs.

EXCEPTION 5 to Section 144 (d): Zones with a peak supply-air quantity of 300 cfm or less.

(e) **Economizers.**

1. Each individual cooling fan system that has a design supply capacity over 2,500 cfm and a total mechanical cooling capacity over 75,000 Btu/hr. shall include either:
 - A. An air economizer capable of modulating outside-air and return-air dampers to supply 100 percent of the design supply air quantity as outside-air; or
 - B. A water economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the commission, at outside air temperatures of 50°F dry-bulb/45°F wet-bulb and below.

EXCEPTION 1 to Section 144 (e) 1: Where it can be shown to the satisfaction of the enforcing agency that special outside air filtration and treatment, for the reduction and treatment of unusual outdoor contaminants, makes compliance infeasible.

EXCEPTION 2 to Section 144 (e) 1: Where the use of outdoor air for cooling will affect other systems, such as humidification, dehumidification, or supermarket refrigeration systems, so as to increase overall building source energy use.

EXCEPTION 3 to Section 144 (e) 1: Systems serving high-rise residential living quarters and hotel/motel guest rooms.

EXCEPTION 4 to Section 144 (e) 1: Where it can be shown to the satisfaction of the enforcing agency that the use of outdoor air is detrimental to equipment or materials in a space or room served by a dedicated space-conditioning system, such as a computer room or telecommunications equipment room.

EXCEPTION 5 to Section 144 (e) 1: Where electrically operated unitary air conditioners and heat pumps have cooling efficiencies that meet or exceed the efficiency requirements of Tables 1-X1 and 1-X2.

2. If an economizer is required by Subparagraph 1, it shall be:
 - A. Designed and equipped with controls so that economizer operation does not increase the building heating energy use during normal operation; and
 - B. Capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

EXCEPTION to Section 144 (e) 2 A: Systems that provide 75 percent of the annual energy used for mechanical heating from site-recovered energy or a site-solar energy source.

3. Air-side economizers shall have high limit shutoff controls complying with Table 1-X3.

Table 1-X1 – Economizer Tradeoff Table for Electrically Operated Unitary Air Conditioners

Climate Zone	Size Category			
	<u>$\geq 760,000$</u>	<u>$\geq 240,000$ and $< 760,000$</u>	<u>$\geq 135,000$ and $< 240,000$</u>	<u>$\geq 65,000$ and $< 135,000$</u>
01	N/A	N/A	N/A	N/A
02	N/A	N/A	N/A	N/A
03	N/A	N/A	N/A	N/A
04	11.9	12.2	12.4	N/A
05	N/A	N/A	N/A	N/A
06	N/A	N/A	N/A	N/A
07	N/A	N/A	N/A	N/A
08	11.9	12.2	12.4	N/A
09	11.6	11.9	12.1	N/A
10	11.4	11.7	11.9	12.4
11	11.5	11.8	12.0	N/A
12	11.7	12.0	12.2	N/A
13	11.2	11.5	11.7	12.3
14	11.7	12.0	12.2	N/A
15	10.0	10.4	10.6	11.3
16	N/A	N/A	N/A	N/A

Table 1-X2 – Economizer Tradeoff Table for Electrically Operated Heat Pumps

Climate Zone	Size Category		
	$\geq 240,000$	$\geq 135,000$ and $< 240,000$	$\geq 65,000$ and $< 135,000$
<u>01</u>	N/A	N/A	N/A
<u>02</u>	N/A	N/A	N/A
<u>03</u>	N/A	N/A	N/A
<u>04</u>	11.7	12.1	N/A
<u>05</u>	N/A	N/A	N/A
<u>06</u>	N/A	N/A	N/A
<u>07</u>	12.3	N/A	N/A
<u>08</u>	11.7	12.0	N/A
<u>09</u>	11.3	11.7	12.5
<u>10</u>	11.1	11.5	12.3
<u>11</u>	11.3	11.6	12.4
<u>12</u>	11.5	11.8	N/A
<u>13</u>	10.9	11.3	12.1
<u>14</u>	11.5	11.8	N/A
<u>15</u>	9.8	10.1	11.1
<u>16</u>	N/A	N/A	N/A

Table 1-X3 – Air Economizer High Limit Shut Off Control Requirements

Device Type	Climate Zones	Required High Limit (Economizer Off When):	
		Equation	Description
Fixed Dry Bulb	01, 02, 03, 05, 11, 13, 14, 15 & 16	$T_{OA} > 75^{\circ}\text{F}$	Outside air temperature exceeds 75°F
	04, 06, 07, 08, 09, 10 & 12	$T_{OA} > 70^{\circ}\text{F}$	Outside air temperature exceeds 70°F
Differential Dry Bulb	All	$T_{OA} > T_{RA}$	Outside air temperature exceeds return air temperature
Fixed Enthalpy ^c	04, 06, 07, 08, 09, 10 & 12	$h_{OA} > 28 \text{ Btu/lb}^b$	Outside air enthalpy exceeds 28 Btu/lb of dry air ^b
Electronic Enthalpy	All	$(T_{OA}, RH_{OA}) > A$	Outside air temperature/RH exceeds the "A" set-point curve ^a
Differential Enthalpy	All	$h_{OA} > h_{RA}$	Outside air enthalpy exceeds return air enthalpy

^a Set point "A" corresponds to a curve on the psychometric chart that goes through a point at approximately 75°F and 40% relative humidity and is nearly parallel to dry bulb lines at low humidity levels and nearly parallel to enthalpy lines at high humidity levels.

^b At altitudes substantially different than sea level, the Fixed Enthalpy limit value shall be set to the enthalpy value at 75°F and 50% relative humidity. As an example, at approximately 6000 ft elevation the fixed enthalpy limit is approximately 30.7 Btu/lb.

^c Fixed Enthalpy Controls are prohibited in climate zones 01, 02, 03, 05, 11, 13, 14, 15 & 16.

- (f) **Supply Air Temperature Reset Controls.** Mechanical space-conditioning systems supplying heated or cooled air to multiple zones shall include controls that automatically reset supply-air temperatures:

1. In response to representative building loads or to outdoor air temperature; and
2. By at least 25 percent of the difference between the design supply-air temperature and the design room air temperature.

Air distribution to zones that are likely to have constant loads, such as interior zones, shall be designed for the fully reset supply temperature.

EXCEPTION 1 to Section 144 (f): Systems that meet the requirements of Section 144 (d), without using Exception 1 or 2 to that section.

EXCEPTION 2 to Section 144 (f): Where supply-air temperature reset would increase overall building energy use.

EXCEPTION 3 to Section 144 (f): Zones in which specific humidity levels are required to satisfy process needs.

- (g) **Electric Resistance Heating.** Electric resistance heating systems shall not be used for space heating.

EXCEPTION 1 to Section 144 (g): Where an electric-resistance heating system supplements a heating system in which at least 60 percent of the annual energy requirement is supplied by site-solar or recovered energy.

EXCEPTION 2 to Section 144 (g): Where an electric-resistance heating system supplements a heat pump heating system, and the heating capacity of the heat pump is more than 75 percent of the design heating load calculated in accordance with Section 144 (a) at the design outdoor temperature specified in Section 144 (b) 4.

EXCEPTION 3 to Section 144 (g): Where the total capacity of all electric-resistance heating systems serving the entire building is less than 10 percent of the total design output capacity of all heating equipment serving the entire building.

EXCEPTION 4 to Section 144 (g): Where the total capacity of all electric-resistance heating systems serving the building, excluding those allowed under Exception 2, is no more than 3 kW.

EXCEPTION 5 to Section 144 (g): Where an electric resistance heating system serves an entire building that:

- A. Is not a high-rise residential or hotel/motel building; and
- B. Has a conditioned floor area no greater than 5,000 square feet; and
- C. Has no mechanical cooling; and
- D. Is in an area where natural gas is not currently available and an extension of a natural gas system is impractical, as determined by the natural gas utility.

- (h) Heat Rejection System Controls.

- 1 General. Subsection 144(h) applies to heat rejection equipment used in comfort cooling systems such as air-cooled condensers, open cooling towers, closed-circuit cooling towers, and evaporative condensers.

2 Fan Speed Control. Each fan powered by a motor of 7.5 hp (5.6 kW) or larger shall have the capability to operate that fan at two-thirds of full speed or less, and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device.

Exception to 144(h):

- A. Heat rejection devices included as an integral part of the equipment listed in Tables 1-C1 through 1-C4.
- B. Condenser fans serving multiple refrigerant circuits.
- C. Condenser fans serving flooded condensers.
- D. Up to 1/3 of the fans on a condenser or tower with multiple fans where the lead fans comply with the speed control requirement

Section 146 – Prescriptive Requirements For Lighting

A building complies with this section if its actual lighting power density calculated under Subsection (a) is no greater than the allowed lighting power density calculated under Subsection (b).

- (a) **Calculation of Actual Lighting Power Density.** The actual lighting power ~~density~~ of the proposed building area is the total watts of all planned permanent and portable lighting systems (including, but not limited to, track and flexible lighting systems, lighting that is integral with modular furniture, workstation task lights, portable freestanding lights, lights attached to workstation panels, movable displays and cabinets, and internally illuminated case work for task or display purposes), subject to the following specific requirements and minus any adjustments allowed under Subsections 1 through 46.

1. In office areas, if the actual watts of portable lighting are not known at the time of permitting, the actual lighting power for portable and integral lighting shall be determined using either (A.) or (B.) following. However, upon installation of the portable lighting systems the building official may require resubmittal of compliance documentation using exact installed lighting and equipment data.

A. In office areas greater than 250 square feet with permanently installed lighting systems a portable light power of 0.2 watts per square foot shall be included in calculation of actual lighting power density; or

B. In office areas of less than 250 square feet, no additional task lighting power will be required in the calculation of actual power.

2. In office areas greater than 250 square feet with permanently installed lighting systems, if sufficient supporting evidence is submitted and accepted by the building official, the actual power for portable lighting shall be included in the calculation of actual power. The individual signing the lighting plans, pursuant to Division three of the California Business and Professions Code, must clearly indicate on the plans the actual power for the portable lighting systems in the area.

43. **Multiple interlocked lighting systems serving a space.** When multiple interlocked lighting systems serve a space, the watts of all systems except the system with the highest wattage may be excluded if:

A. The lighting systems are interlocked to prevent simultaneous operation; or

B. The lighting systems are controlled by a preset dimming system or other device that prevents simultaneous operation of more than one lighting system, except under the direct control of authorized personnel.

24. **Reduction of wattage through controls.** The watts of any luminaire that is controlled | may be reduced by the number of watts times the applicable factor from Table 1-L if:

- A. The control complies with Section 119; and
- B. At least 50 percent of the light output of the luminaire is within the applicable space listed in Table 1-L; and
- C. Except as noted in Table 1-L, only one power adjustment factor is used for the luminaire; and
- D. For daylighting control credits, the luminaire is controlled by the daylighting control, and the luminaire is located within the daylit area.

TABLE 1-L—LIGHTING POWER ADJUSTMENT FACTORS

TYPE OF CONTROL	TYPE OF SPACE		FACTOR
Occupant sensor With separate sensor for each space	Any space ≤ 250 square feet enclosed by opaque floor-to-ceiling partitions; any size classroom, corridor, conference or waiting room		0.20
	Rooms of any size that are used exclusively for storage		0.60
	Greater than 250 square feet		0.10
Dimming system Manual	Hotels/motels, restaurants, auditoriums, theaters		0.10
	Multiscene programmable		0.20
Lumen maintenance controls	Any space		0.05
Tuning	Any space		0.10
Automatic time switch control device	< 250 square feet and with a timed manual override at each switch location required by Section 131 (a), and controlling only the lights in the area enclosed by ceiling-height partitions.		0.05
Combined controls Occupant sensor with a separate sensor for each space used in conjunction with lumen maintenance controls	Any space ≤ 250 square feet and enclosed by opaque floor-to-ceiling partitions		0.25
	Hotels/motels, restaurants, auditoriums, theaters		0.35
	Occupant sensor with programmable multiscene dimming system		
Occupant sensor with a separate sensor for each space used in conjunction with daylighting controls and separate sensor for each space	Any space ≤ 250 square feet within a daylit area and enclosed by opaque floor-to-ceiling partitions		0.10 (may be added to daylighting control credit)
Automatic Daylighting Controls (Stepped/Dimming)			
	WINDOWS		
	Window Wall Ratio		
Glazing Type	< 20%	20% to 40%	> 40%
VLT ≥ 60%	0.20/0.30	0.30/0.40	0.40/0.40
VLT ≥ 35 and < 60%	0/0	0.20/0.30	0.30/0.40
VLT < 35%	0/0	0/0	0.20/0.40
	SKYLIGHTS		
	Percentage of Gross Exterior Roof Area		
Glazing Type	< 1%	1% to 3%	> 3%
VLT ≥ 60%	0/0.30	0.15/0.40	0.30/0.40
VLT ≥ 35 and < 60%	0/0.20	0/0.30	0.15/0.40
VLT < 35%	0/0.10	0/0.20	0/0.30

35. Lighting wattage excluded. The watts of the following lighting applications may be excluded from the actual lighting power density of the building:

- A. Lighting for theme parks and special effects lighting for dance floors;
 - B. Lighting for film, video or photography studios;
 - C. Lighting for exhibits or for theatrical and other live performances, in exhibit, convention areas, and in hotel function areas, if the lighting is an addition to a general lighting system, and if the lighting is controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators;
 - D. Specialized local lighting installed in nonlighting equipment by its manufacturer;
 - E. In medical and clinical buildings, examination and surgical lights, low-level night lights, and lighting integral to medical equipment;
 - F. In restaurant buildings and areas, lighting for food warming or integral to food preparation equipment;
 - G. Interior lighting in refrigerated cases;
 - H. Lighting for plant growth or maintenance, if it is equipped with an automatic 24-hour time switch that has program backup capabilities that prevent the loss of the switch's program and time setting for at least 10 hours if power is interrupted;
 - I. Lighting equipment that is for sale;
 - J. Lighting demonstration equipment in lighting education facilities;
 - K. Lighting that is required for exit signs subject to Section 1013 of the UBC if it has an efficacy of at least 40 lumens per watt and has a power factor greater than 90 percent;
 - L. Exitway or egress illumination that is normally off and that is subject to Section 1012 of the UBC;
 - M. Exitway or egress lighting whose switching is regulated by Article 3-700 of the California Electrical Code (Title 24, Part 3);
 - N. In hotel/motel buildings, lighting in guest rooms;
 - O. In high-rise residential buildings, lighting in living quarters.
-

P. The lighting system using the least wattage in a redundant lighting system interlocked or otherwise controlled to prohibit simultaneous operation of more than one lighting system.

46. **Lighting fixtures.** The watts of track and other lighting fixtures that allow the substitution of low efficacy sources for high efficacy sources without altering the wiring of the fixture shall be determined by a method approved by the commission.

(b) **Calculation of Allowed Lighting Power Density.** The allowed lighting power density for each application for a building permit shall be calculated using one and only one of the methods in Subsection 1, 2, or 3, as applicable.

1. **Complete building method.** The Complete Building Method may be used only on projects involving entire buildings with one occupancy type or mixed occupancy buildings where one occupancy makes up 90 percent of the conditioned floor area of the entire building. This approach may only be used when the applicant is applying for a lighting permit for, and submits plans and specifications for, the entire building. Under this approach, the allowed lighting power density is the lighting power density value in Table 1-M times the conditioned floor area of the entire building. Hotel/motel and high-rise residential buildings shall not use this method.

**TABLE 1-M—COMPLETE BUILDING METHOD LIGHTING
POWER DENSITY VALUES (Watts/ft.²)**

TYPE OF USE	ALLOWED LIGHTING POWER
General commercial and industrial work buildings	
High bay	1.2
Low bay	1.0
Grocery stores	1.5
Industrial and commercial storage buildings	0.7
Medical buildings and clinics	1.2
Office buildings	1.2
Religious facilities, <u>and</u> auditorium and convention centers	1.8
<u>Convention centers</u>	<u>1.4</u>
Restaurants	1.2
Retail and wholesale stores	1.7
Schools	1.4
Theaters	1.3
All others	0.6

2. **Area category method.** Under the Area Category Method, the total allowed lighting power for the building is the sum of all allowed lighting powers for all areas in the building. For purposes of the area Category Method, an "area" shall be defined as all contiguous spaces which accommodate or are associated with a single one of the primary functions listed in Table 1-N. Where areas are bounded or separated by interior partitions, the floor space occupied by those interior partitions shall be included in any area. When the Area Category Method is used to calculate the allowed

total lighting power for an entire building, main entry lobbies, corridors, restrooms, and support functions shall be treated as separate areas.

EXCEPTION to Section 146 (b) 2: The tailored method [Section 146 (b) 3] may be used for up to 10 percent of the floor area of a building that is otherwise using the Area Category Method. The two lighting methods cannot be used for the same floor area. The floor area for calculations based on the Tailored Method must be subtracted from the floor area for the remainder of the building lighting calculations. Trade-offs of lighting between the two methods is not allowed.

**TABLE 1-N—AREA CATEGORY METHOD - LIGHTING POWER
DENSITY VALUES (Watts/ft.²)**

PRIMARY FUNCTION	ALLOWED LIGHTING POWER
Auditorium	2.0*
Auto repair	1.2
Bank/financial institution	1.4
Classrooms, lecture, training, vocational room	1.6
Commercial and industrial storage	0.6
Convention, conference, multipurpose and meeting centers	1.6 1.5*
Corridors, restrooms, stairs and support areas	0.6
Dining	1.1*
Electrical, mechanical rooms	0.7
Exercise center, gymnasium	1.0
Exhibit, museum	2.0
General commercial and industrial work	
High bay	1.2
Low bay	1.0
Grocery store	1.6
Hotel function area	2.2*
Kitchen, food preparation	1.7
Laundry	0.9
Library	
Reading areas	1.2
Stacks	1.5
Lobbies:	
Hotel lobby	2.2 1.7*
Main entry lobby	1.5*
Reception/waiting	1.1*
Locker/dressing room	0.9 0.8
Lounge/recreation	1.1
Malls, arcades and atria	1.2*
Medical and clinical care	1.4
Office	1.3
Precision commercial or industrial work	1.5
Religious worship	2.1*
Retail sales, wholesale showrooms	2.0
Theaters	
Motion picture	0.9
Performance	1.4*
All other	0.6

* The smallest of the following values may be added to the allowed lighting power listed in Table 1-N for ornamental chandeliers and sconces that are switched or dimmed on circuits different from the circuits for general lighting:

- a. 20 watts per cubic foot times the volume of the chandelier or sconce; or
- b. One watt per square foot times the area of the task space that the chandelier or sconce is in; or
- c. The actual design wattage of the chandelier or sconce.